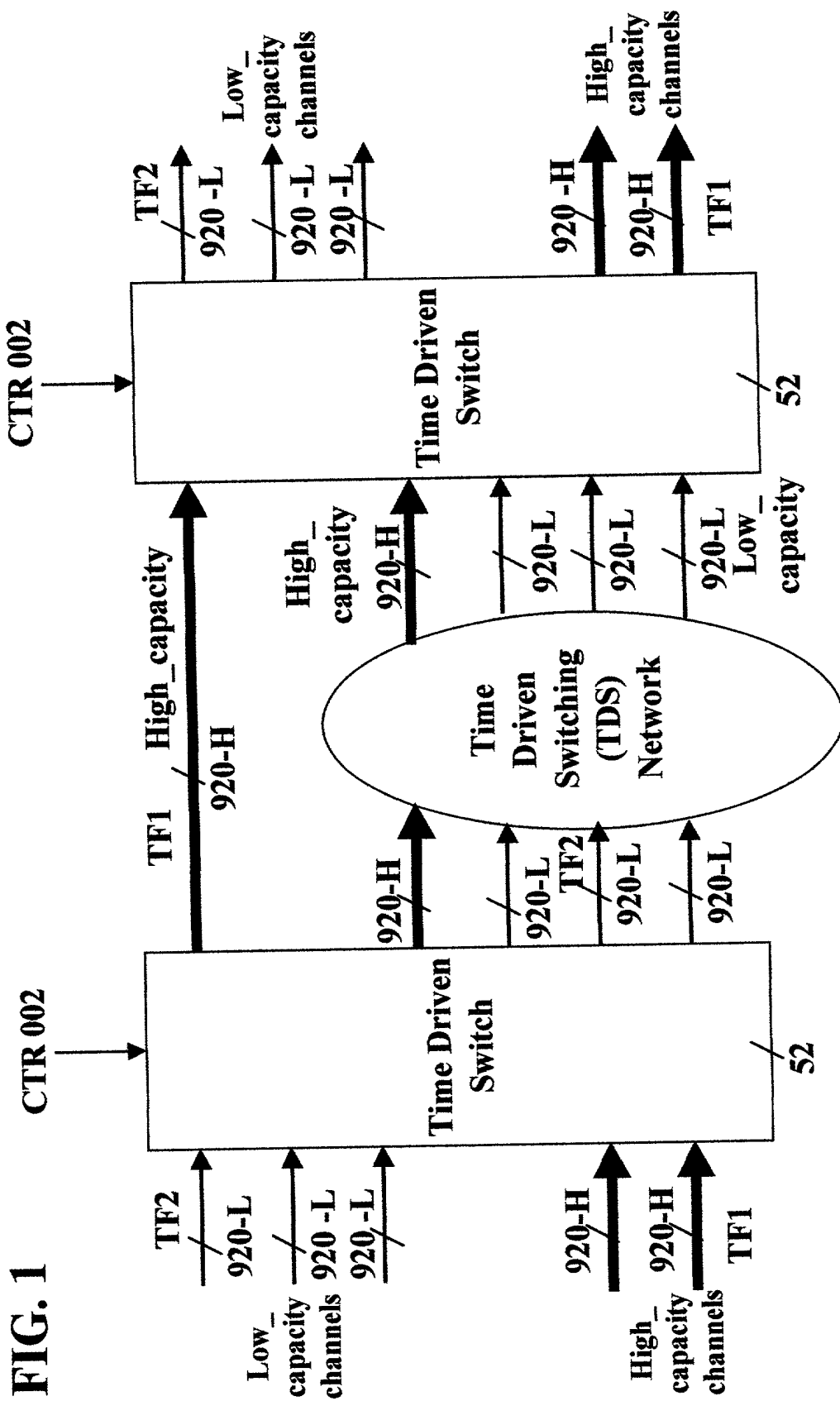


#3



c = High_capacity/Low_capacity

205710" FEB 29 1990

Example:

TF1=15.325 microsec - High_capacity = OC-192

TF2 = 125 microsec - Low_capacity = OC-3

$\Rightarrow c = 64 = (OC-192/OC-3)$

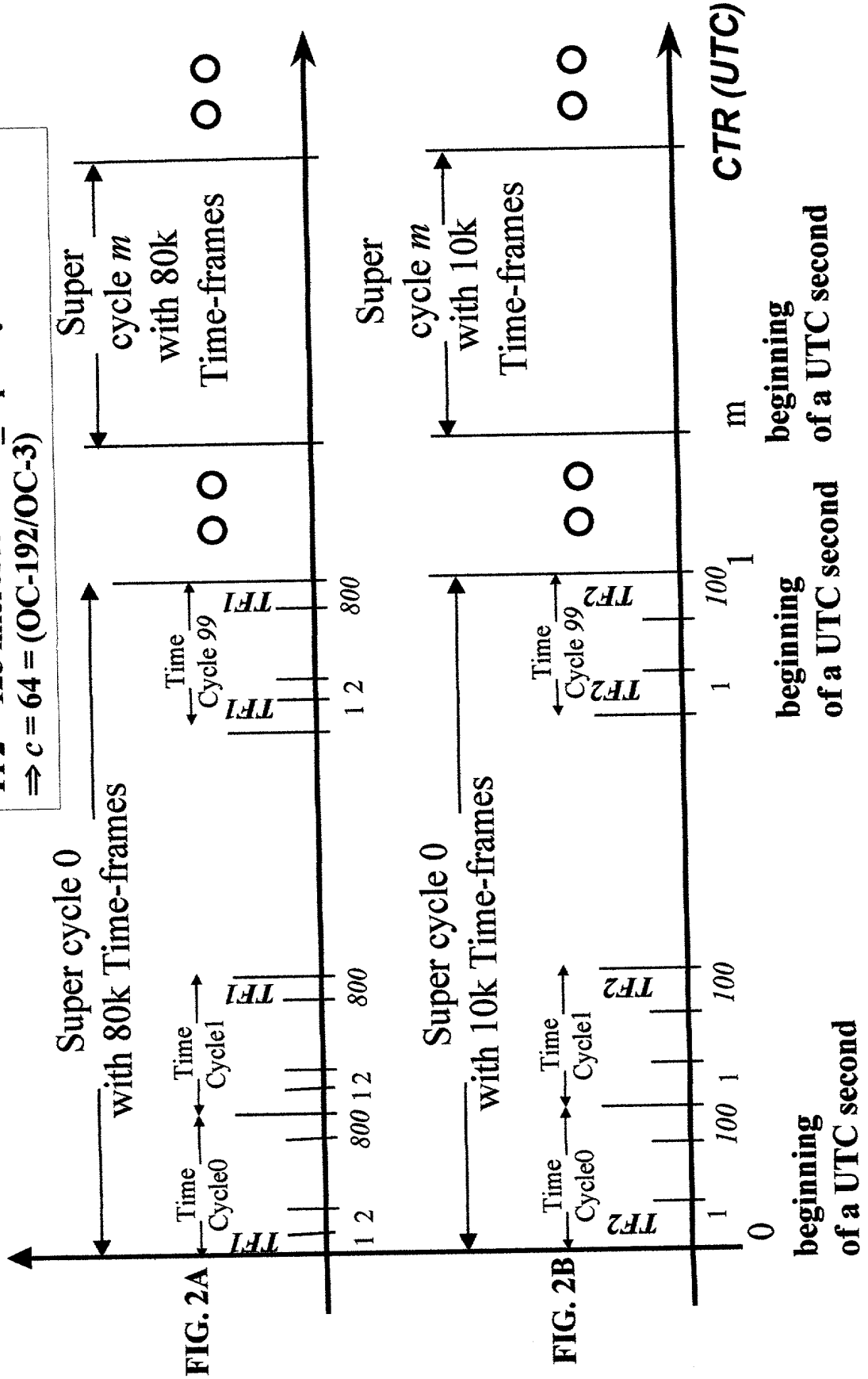
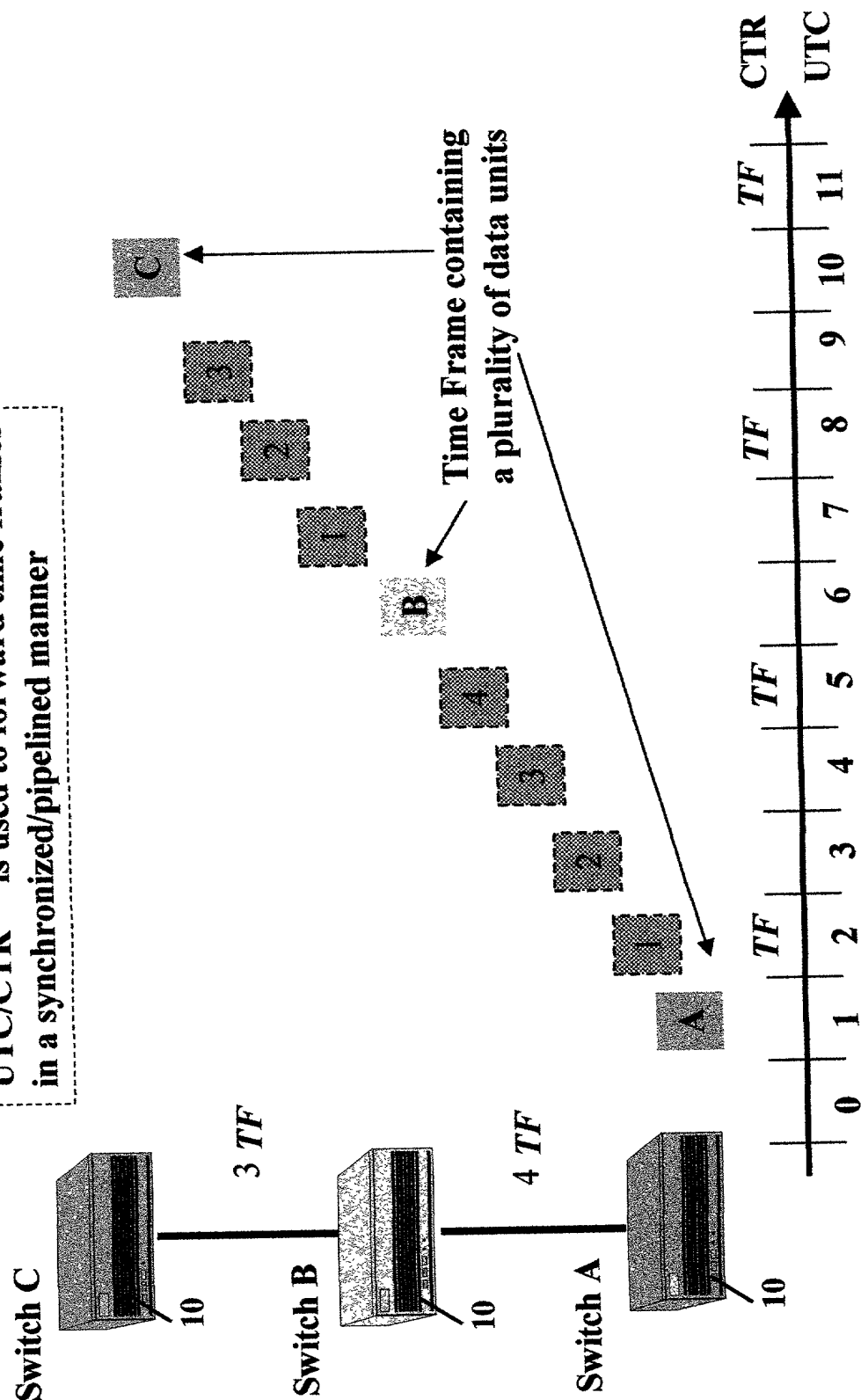


FIG. 3

UTC/CTR™ is used to forward time frames
 in a synchronized/pipelined manner



205710" T80T9660

2057137-1

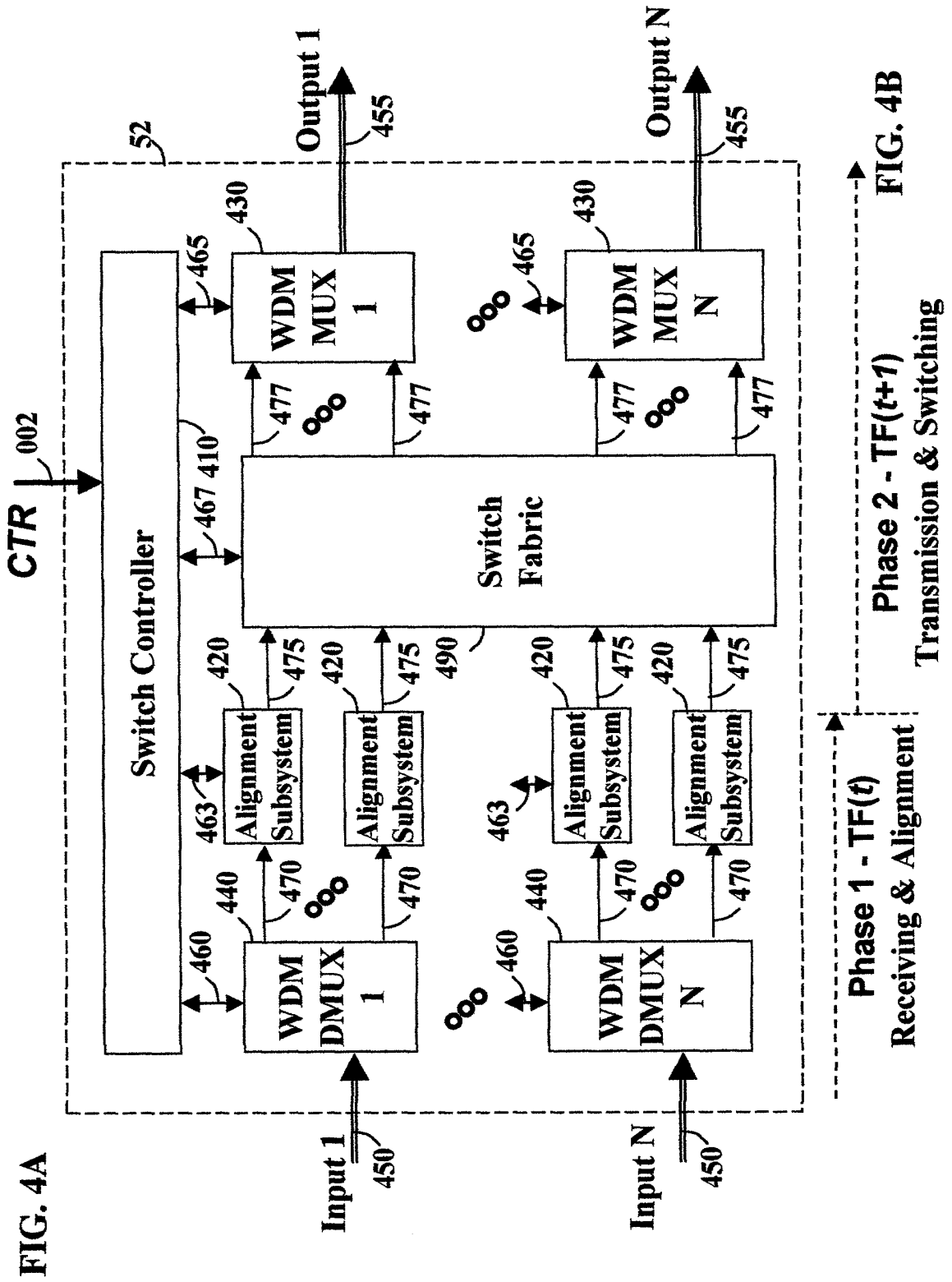


FIG. 5

Two time intervals: $SC1_length \cdot TF1 = 1$ UTC second

- $SC2_length \cdot TF2 = 1$ UTC second
- $TF2 = (SC1_length / SC2_length) \cdot TF1 = k \cdot TF1$, where the time cycles of TF1 and TF2 are aligned with respect to UTC.

For $k = 2$ and $c = 4$ (e.g., $High_capacity = OC-192$, $Low_capacity = OC-48$):

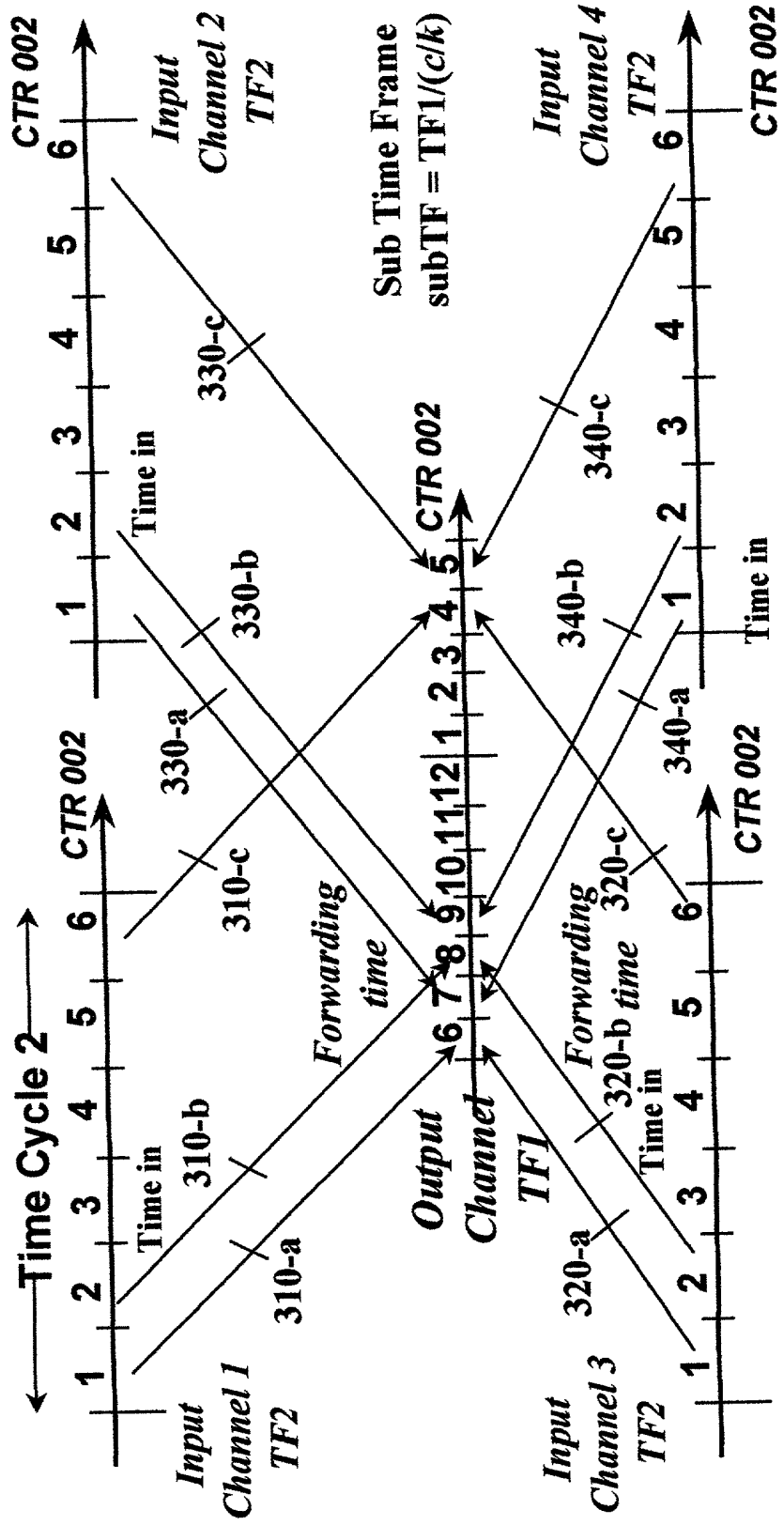


FIG. 6 Two time intervals: $SC1_length \cdot TF1 = 1$ UTC second

- $SC2_length \cdot TF2 = 1$ UTC second
- $TF2 = (SC1_length / SC2_length) \cdot TF1 = k \cdot TF1$, where the time cycles of $TF1$ and $TF2$ are aligned with respect to UTC.

For $k = 2$ and $c = 4$ (e.g., High_capacity=OC-192, Low_capacity=OC-48):

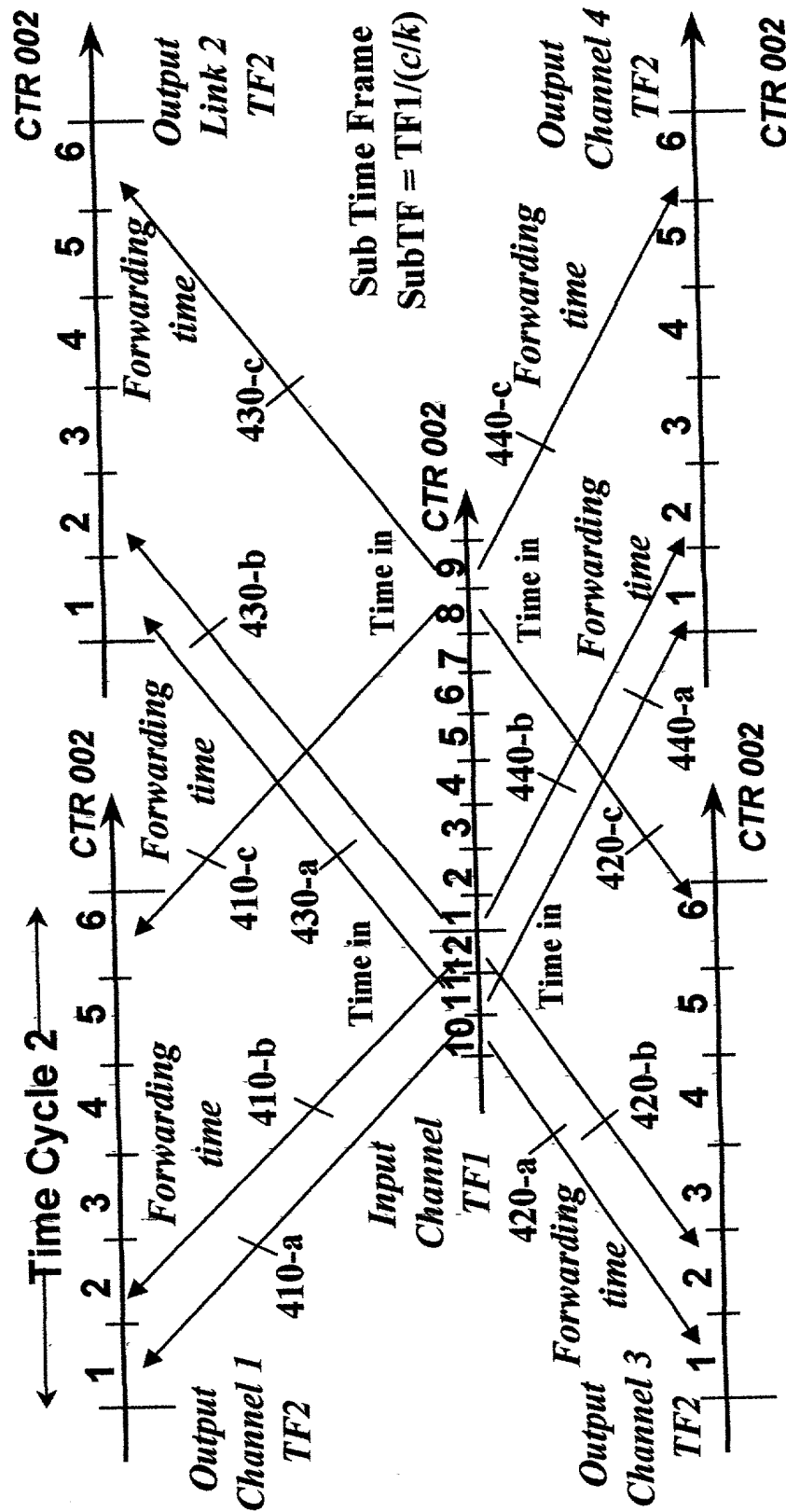


FIG. 7

Two time intervals: $SC1_length \cdot TF1 = 1$ UTC second

- $SC2_length \cdot TF2 = 1$ UTC second
 - $TF2 = (SC1_length / SC2_length) \cdot TF1 = k \cdot TF1$, where the time cycles of $TF1$ and $TF2$ are aligned with respect to UTC.
- For $k = 2$ and $c = 4$ (e.g., $High_capacity = OC-192$, $Low_capacity = OC-48$):

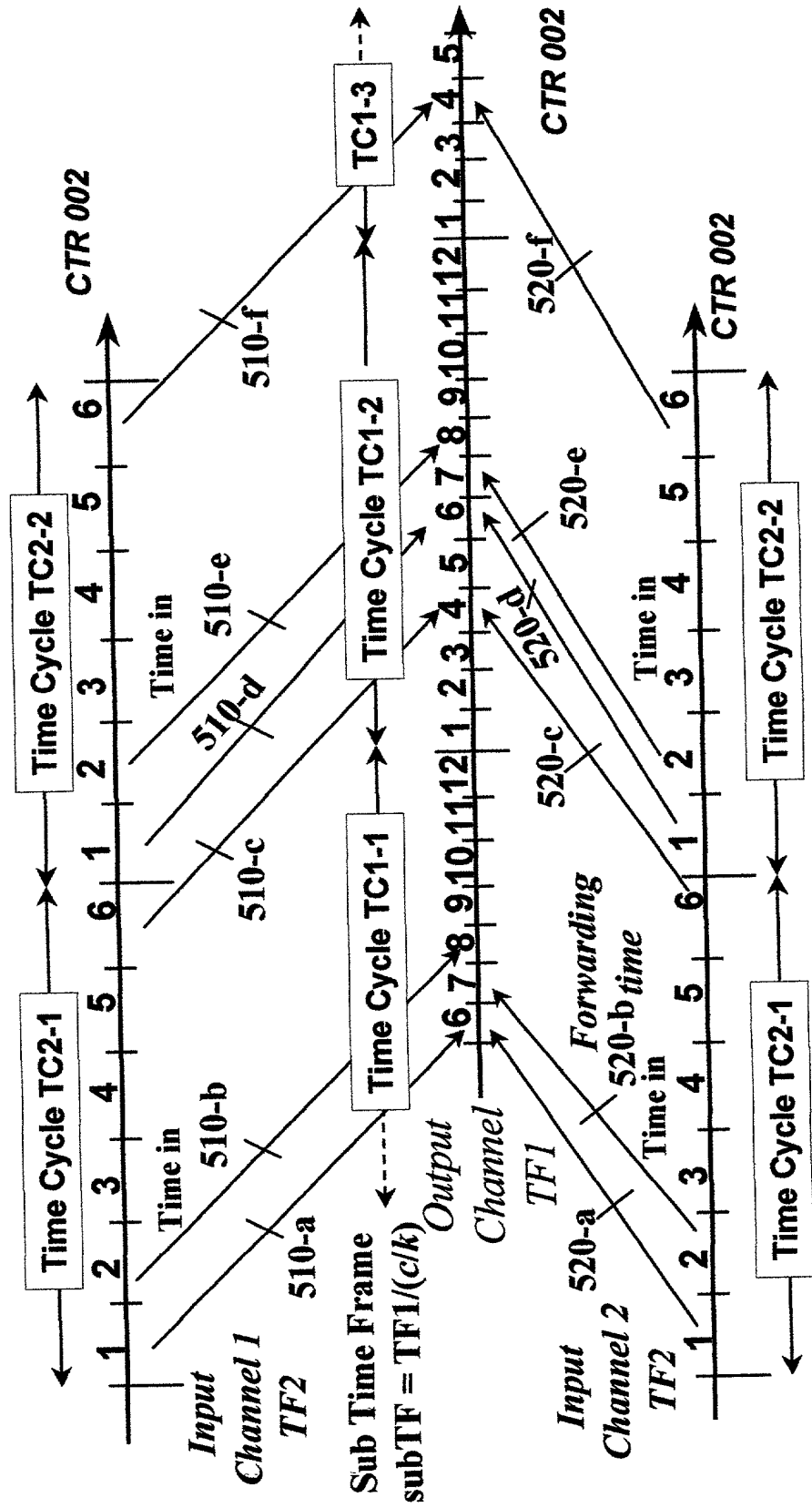


FIG. 8

- Two time intervals: $SC1_length \cdot TF1 = 1$ UTC second
- $SC2_length \cdot TF2 = 1$ UTC second
 - $TF2 = (SC1_length / SC2_length) \cdot TF1 = k \cdot TF1$, where the time cycles of $TF1$ and $TF2$ are aligned with respect to UTC.
- For $k = 2$ and $c = 4$ (e.g., High_capacity=OC-192, Low_capacity=OC-48):

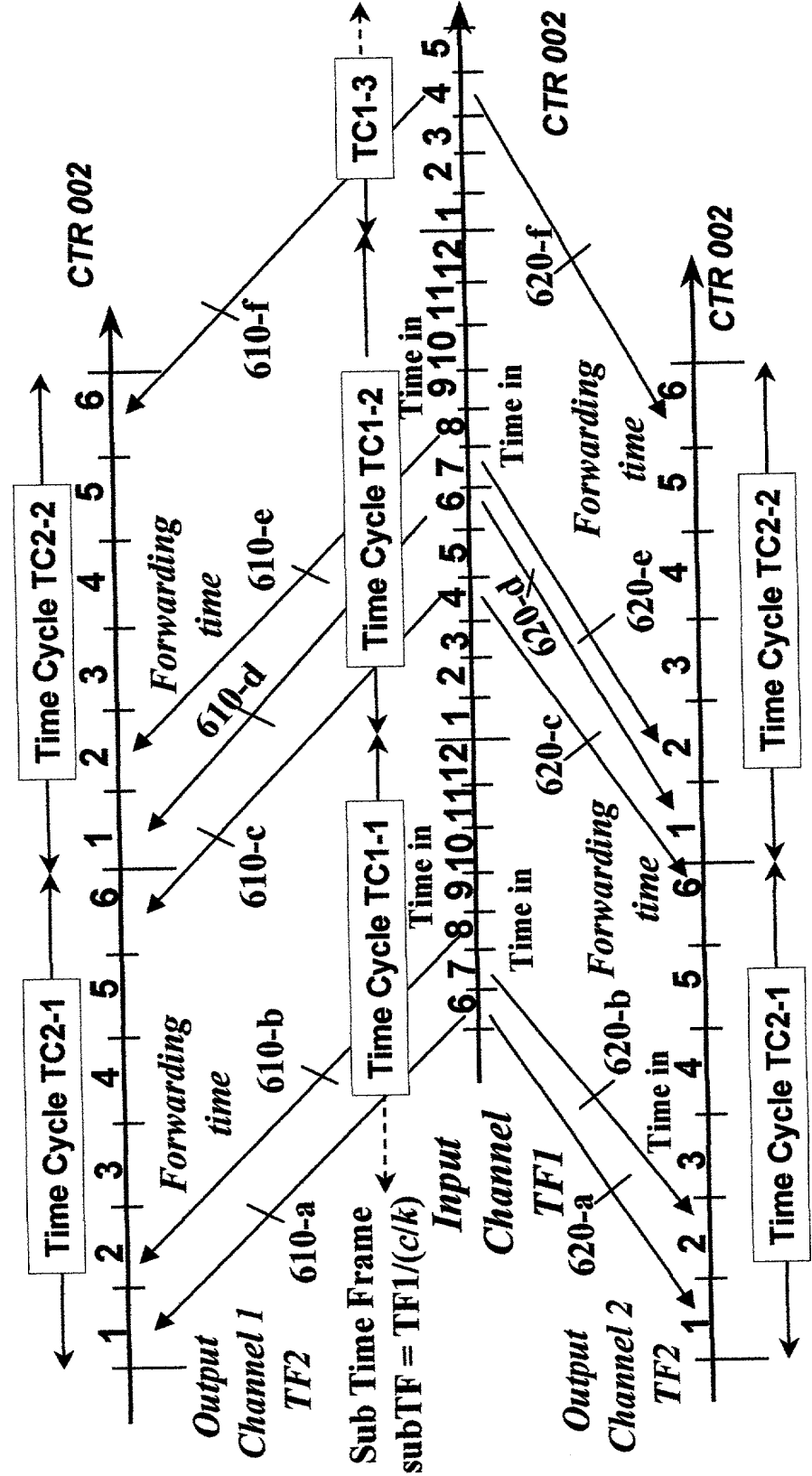


FIG. 9

$c=4$, e.g., OC-192/OC-48
 $k=2$, e.g., 25 microsec/12.5 microsec

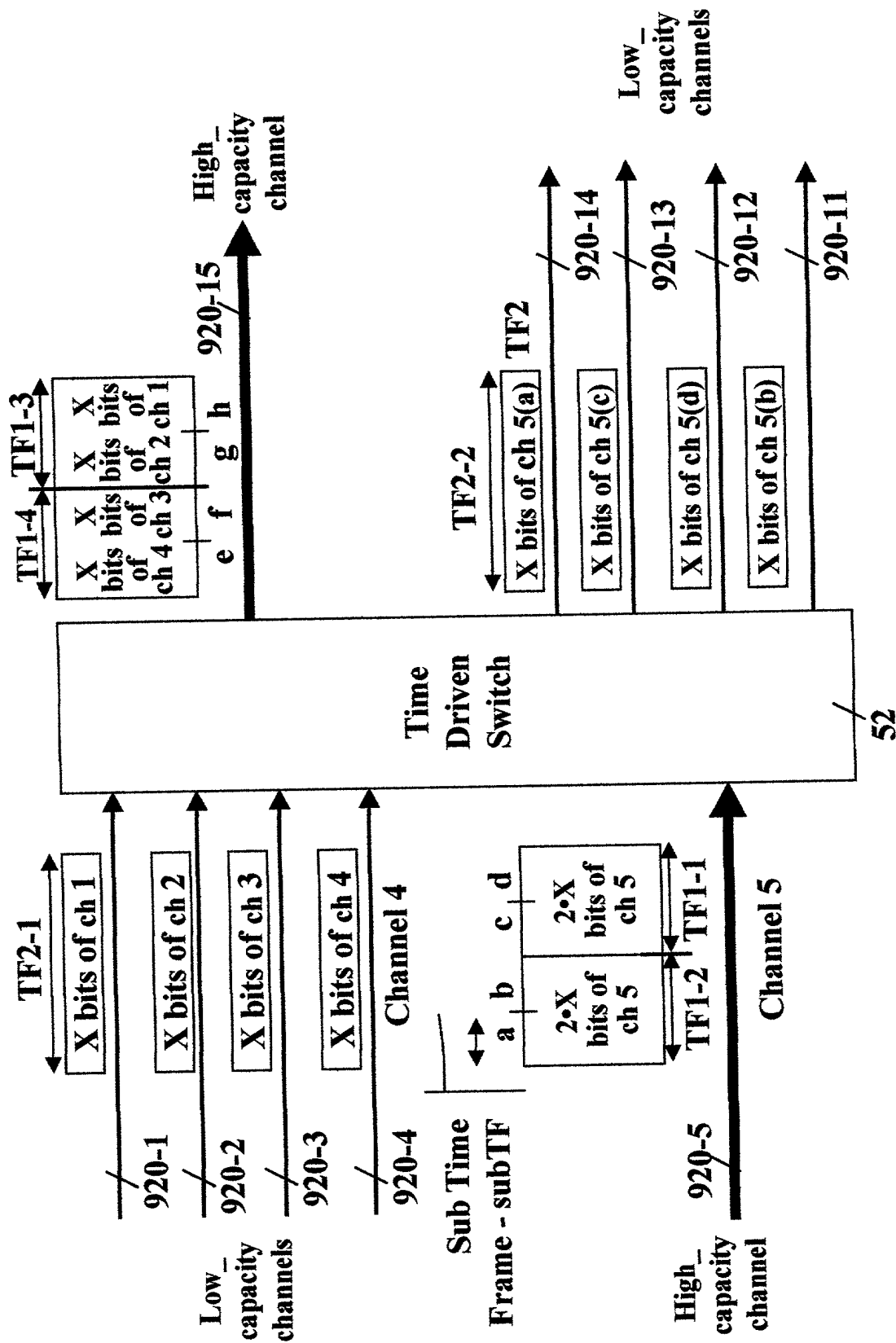
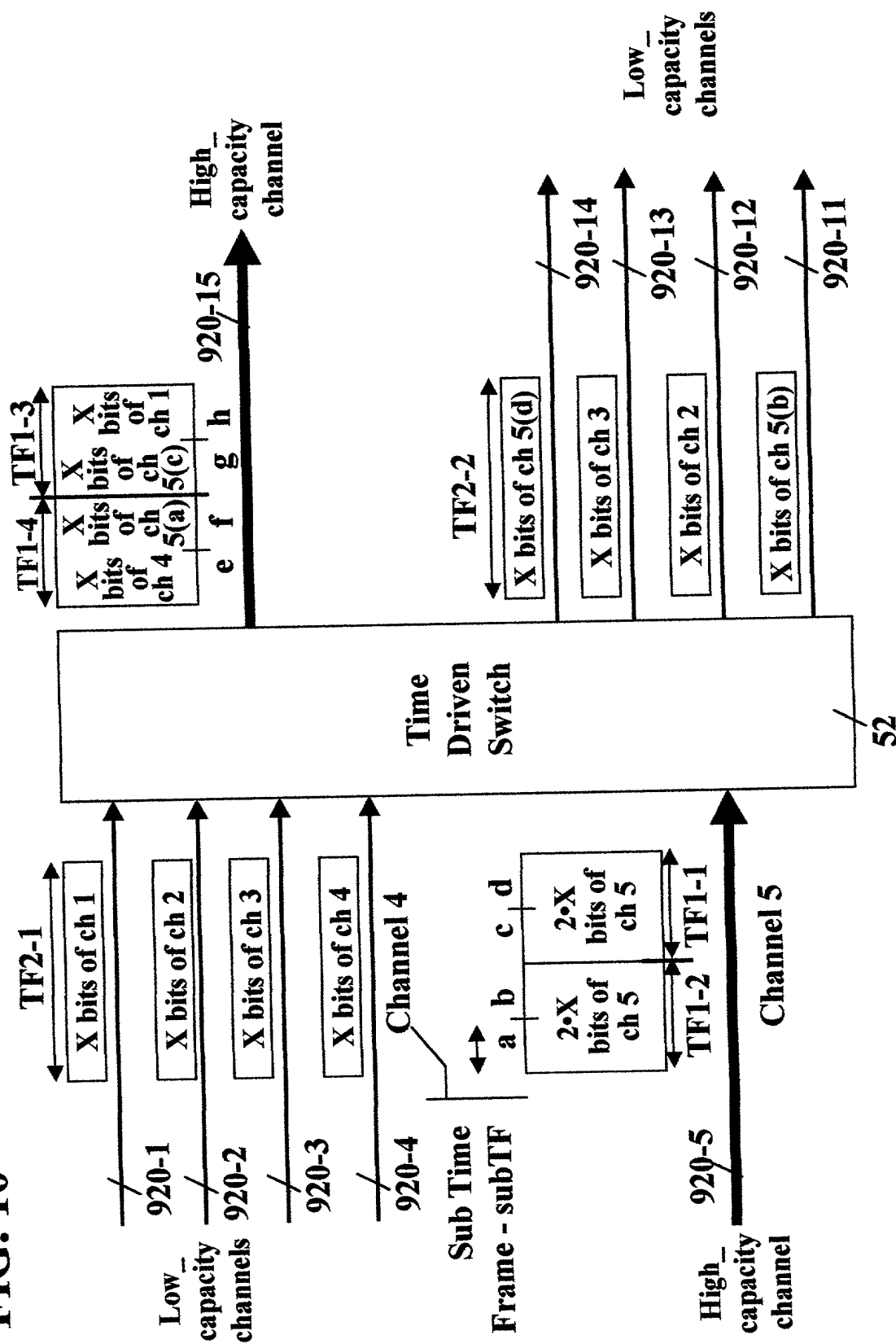


FIG. 10

$c=4$, e.g., OC-192/OC-48
 $k=2$, e.g., 25 microsec/12.5 microsec



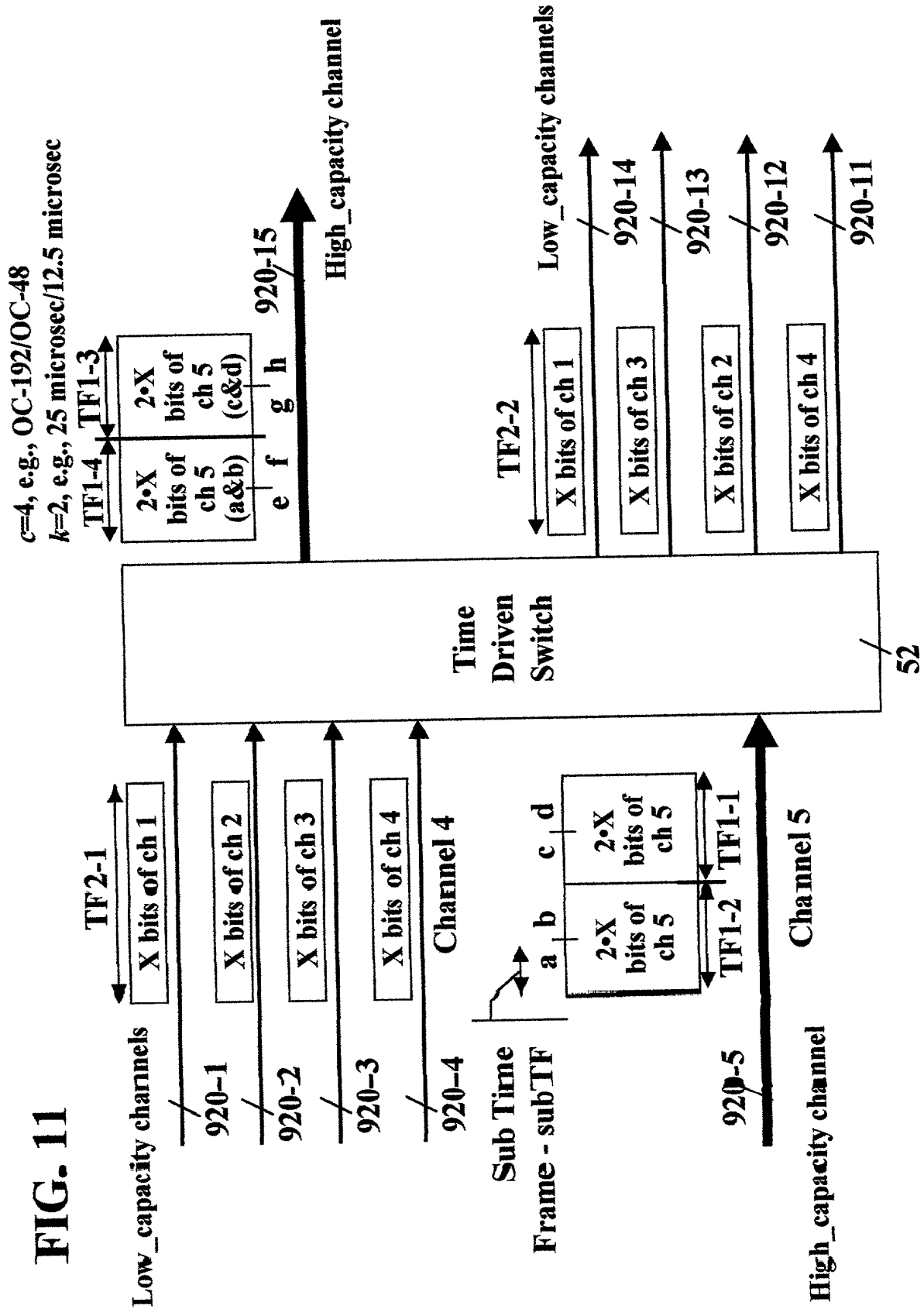


FIG. 12A

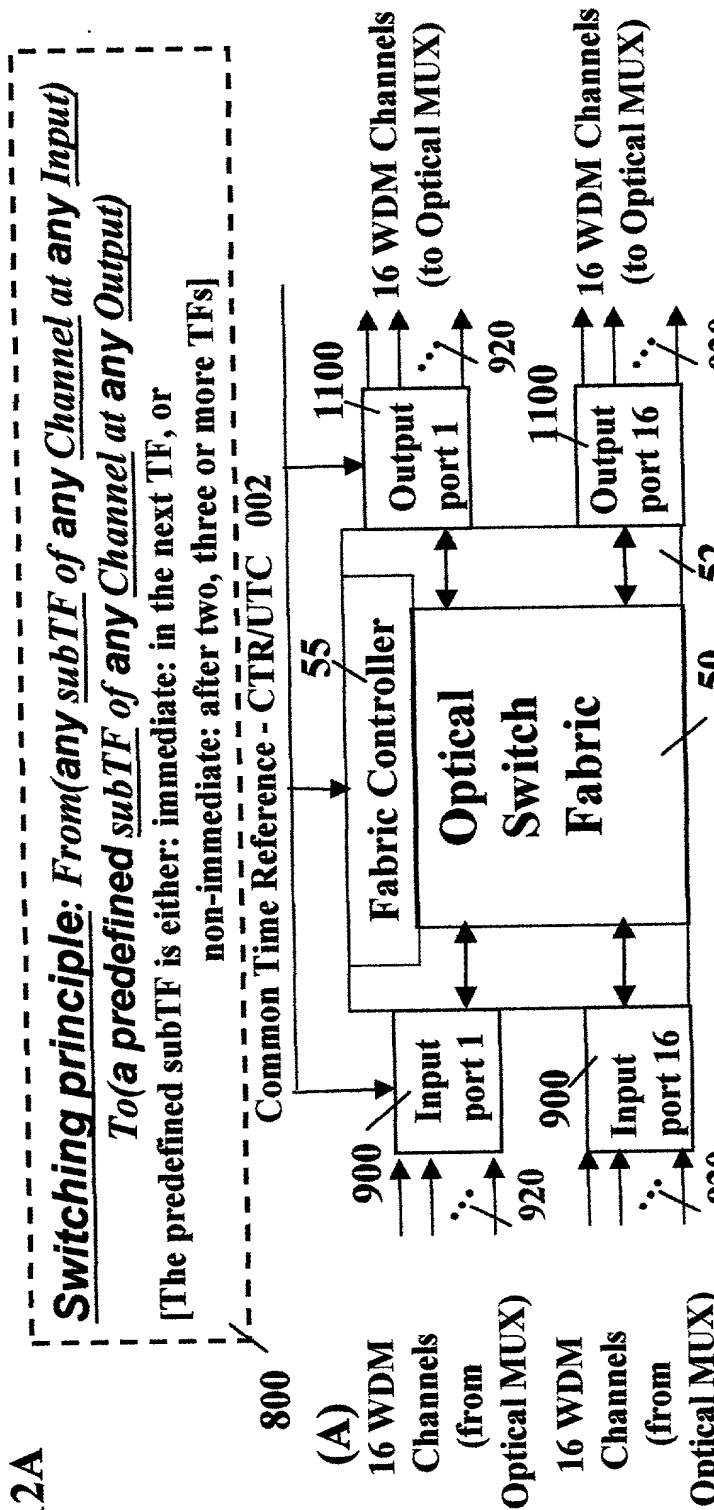


FIG. 12B

Phase 1
TF_{i,j}(t) - e.g., 62.5 μs
Receiving & Alignment

Phase 2

subTF(t+1) - 15.325 μs
Switching & Transmitting

FIG. 12C

Phase 1
TF_{i,j}(t) - e.g., 62.5 μs
Receiving & Alignment

Phase 2

subTF(t+1) - 15.325 μs
Switching

Phase 3

TF_{i,j}(t) - e.g., 62.5 μs
Transmitting

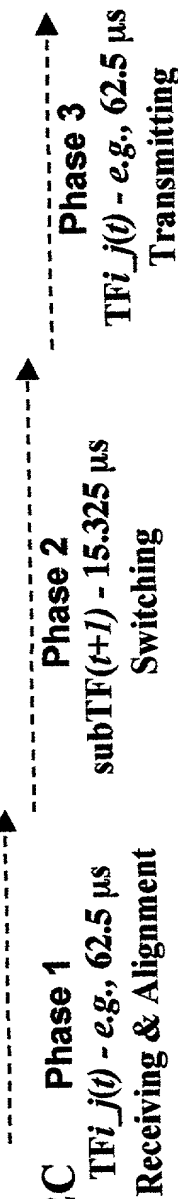


FIG. 13

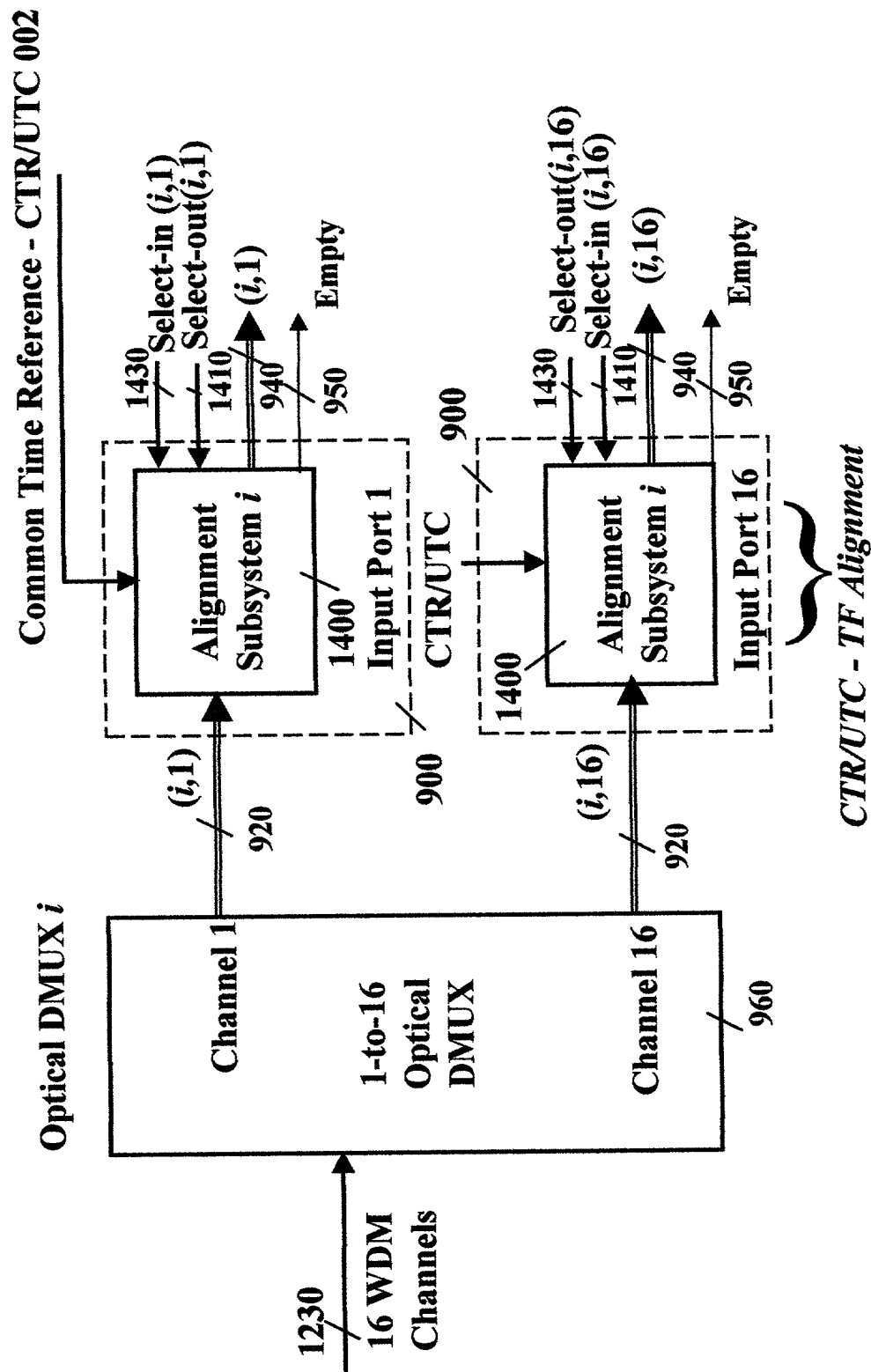
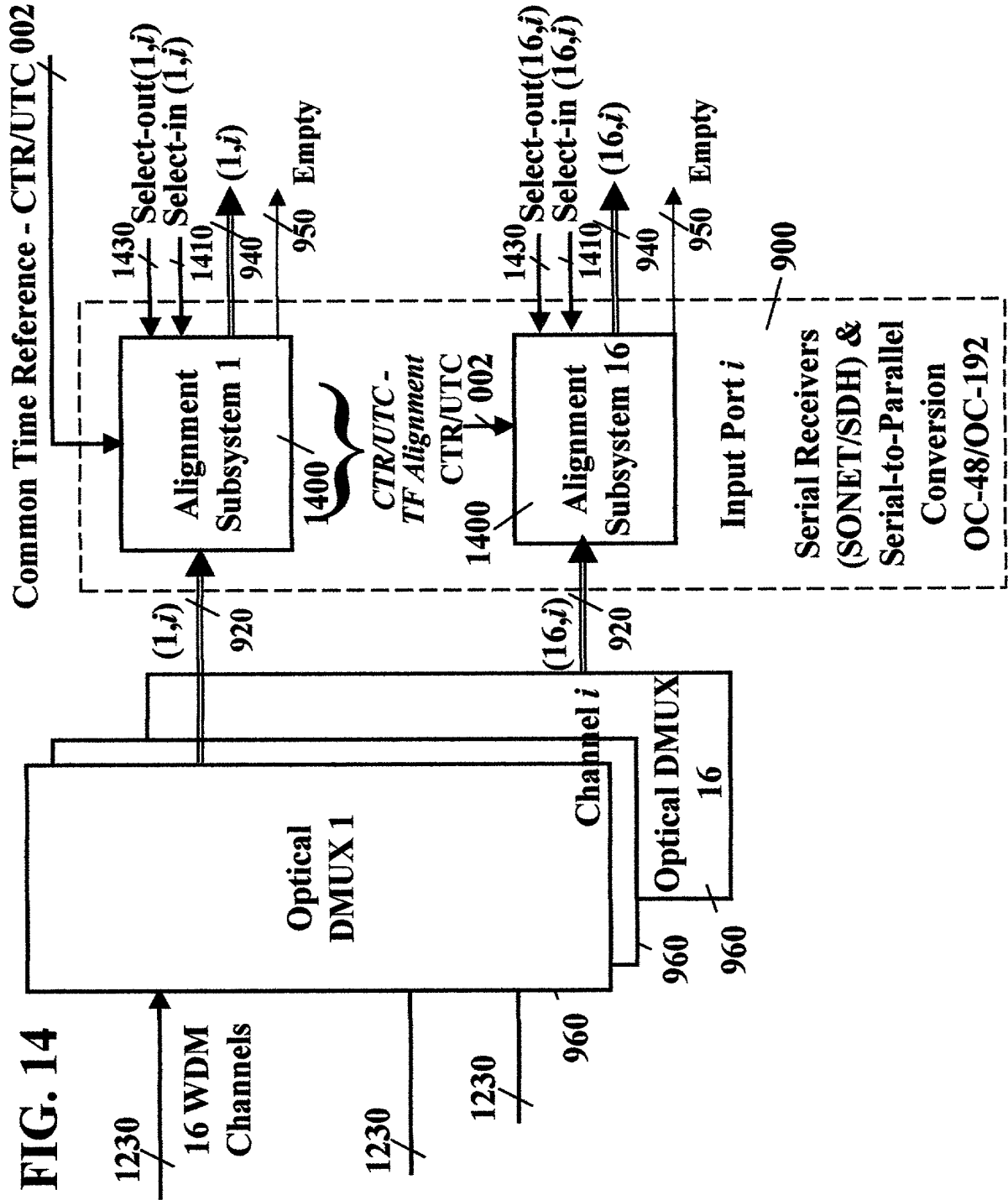


FIG. 14



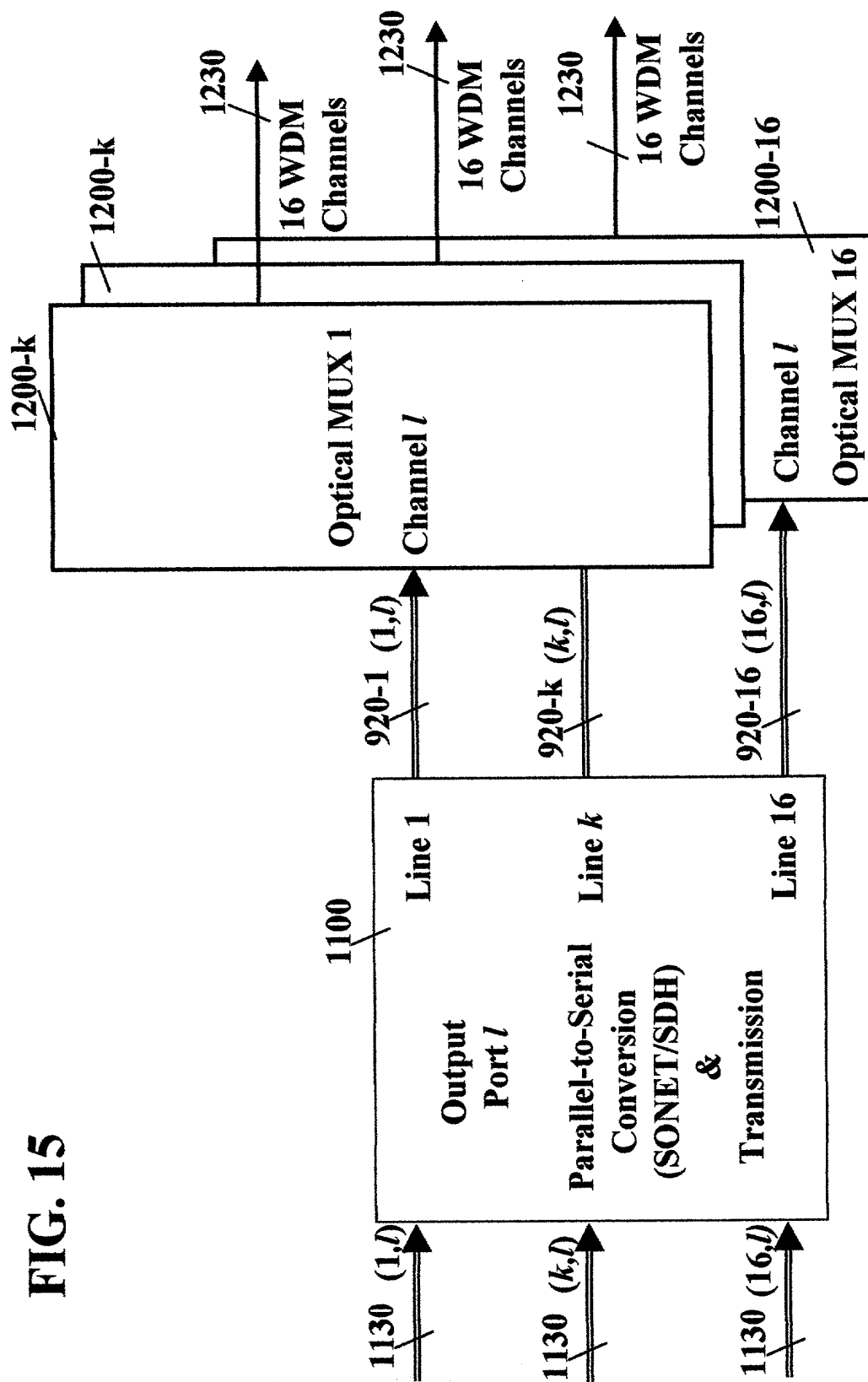
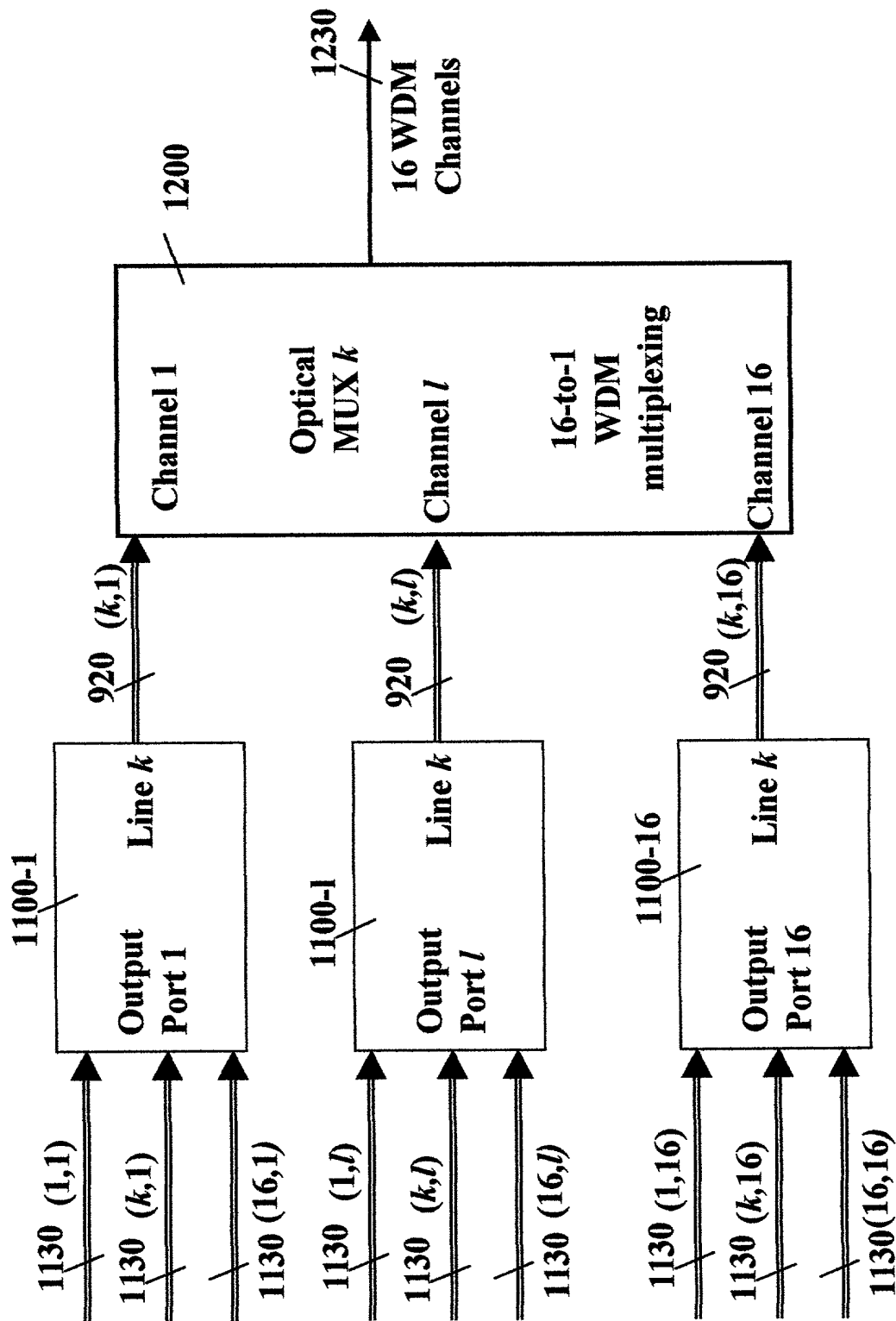


FIG. 15

205110" T80T9560

FIG. 16



205710" T80T9660

FIG. 17 N: number of input/output channels. E.g., N=256

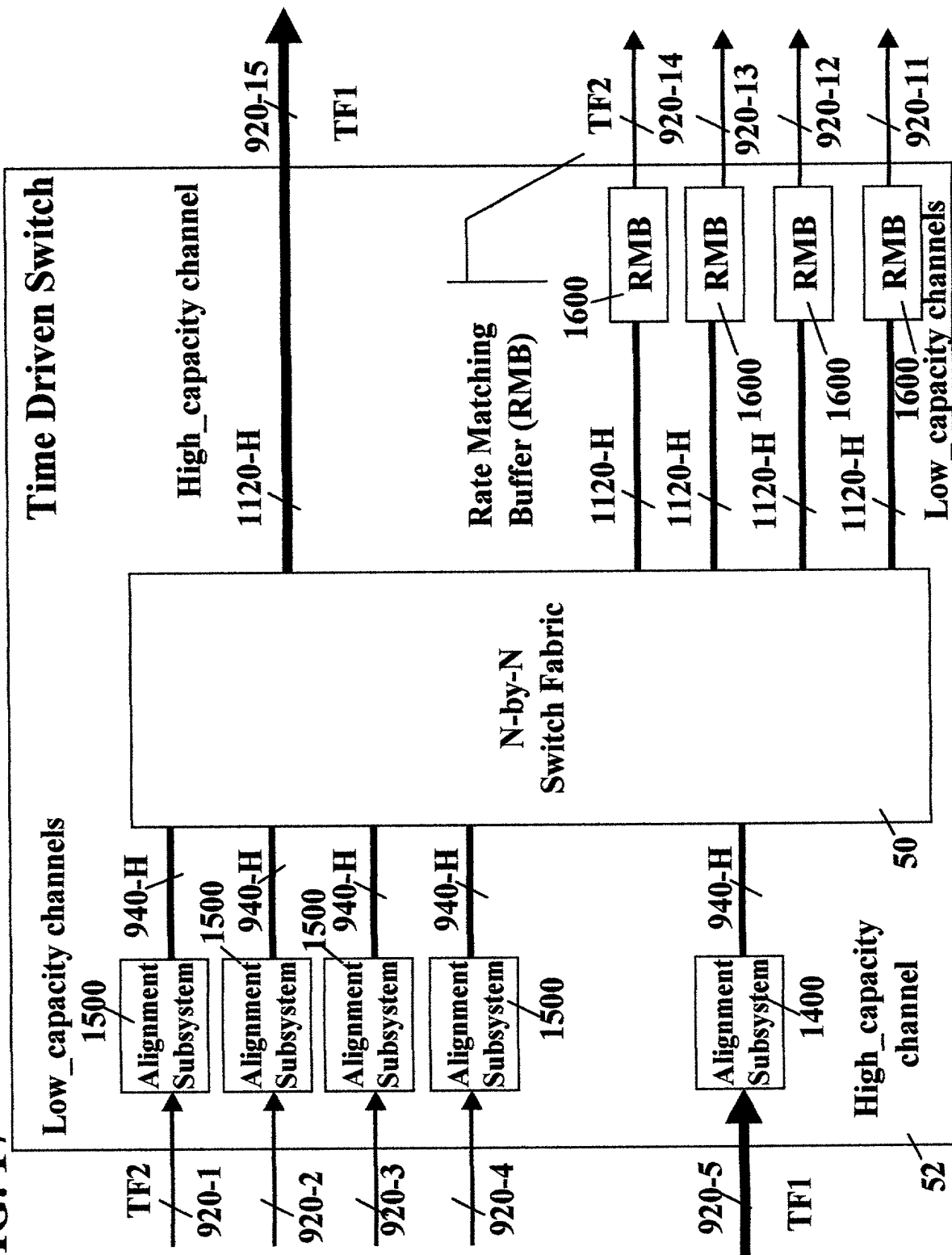
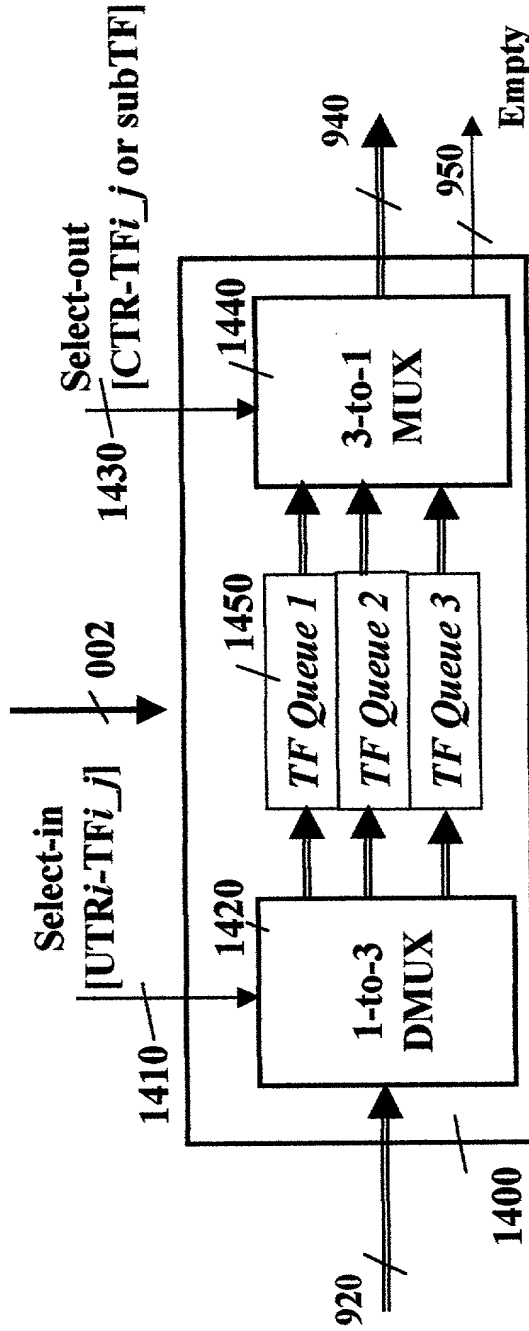


FIG. 18

TFi_j: Time frame duration on channel *j* at Input Interface *i*.
UTR_i: UTR on link connected to Input Interface *i*
Common Time Reference - CTR/UTC



Alignment Subsystem for Channel *j* at Input Interface *i*
with a Plurality of Time Frame Queues

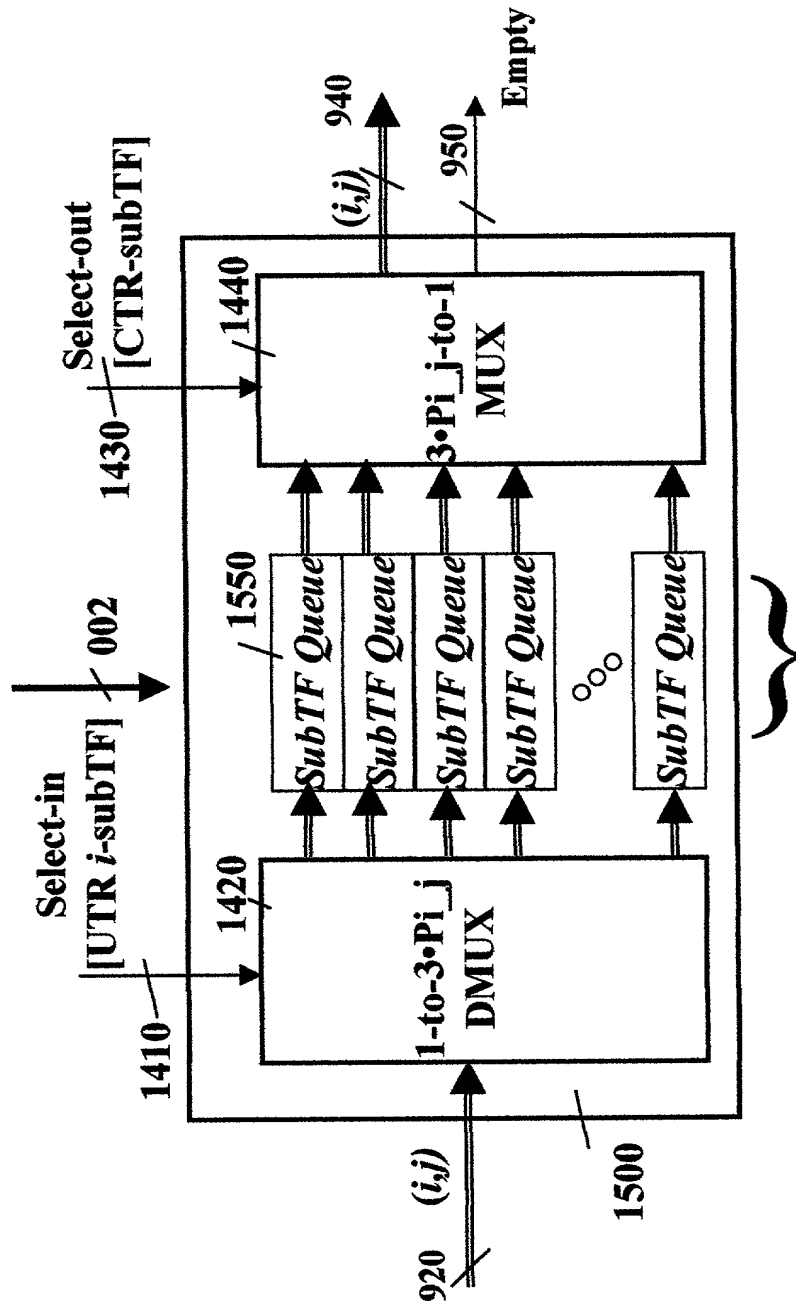
FIG. 19

$TF_{i,j}$: Time frame duration on channel j at Input Interface i .

UTR_i : UTR on link connected to Input Interface i

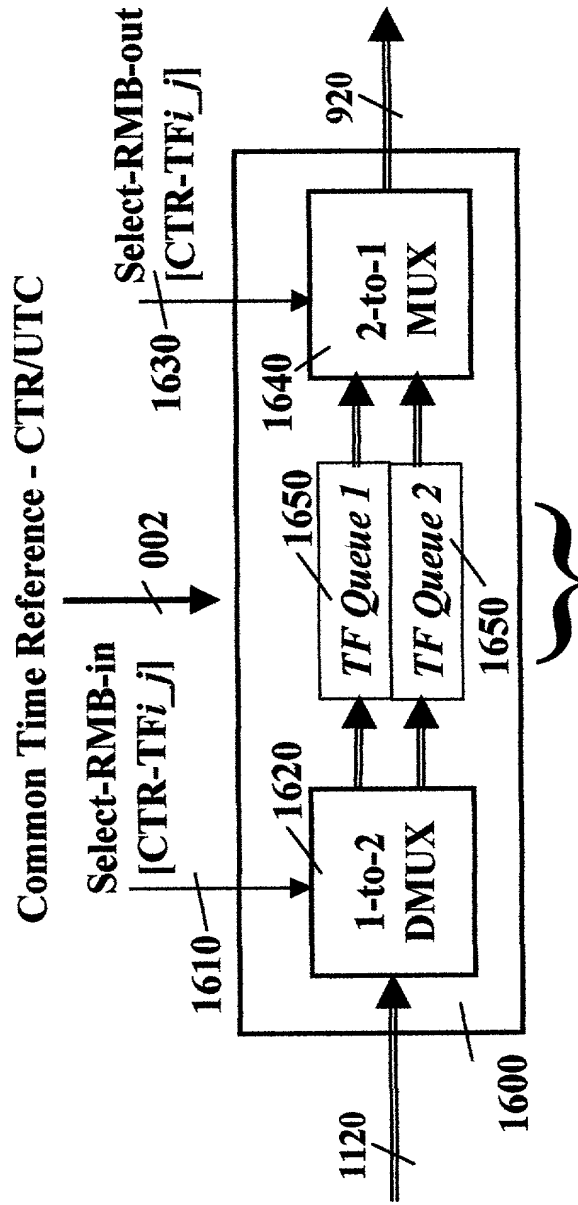
$Pi_j = TF_{i,j}/subTF$

Common Time Reference - CTR/UTC



Alignment Subsystem for high capacity Channel j at Input Interface i
 with a Plurality of Sub-Time Frame Queues

FIG. 20 TFi_j : Time frame duration on channel j at Input Interface i .
 UTR i : UTR on link connected to Input Interface i



Rate Matching Buffer for Channel j at Output Interface i
with a Plurality of Time Frame Queues
 (Also single buffer with dual access memory with single phase switching and forwarding)

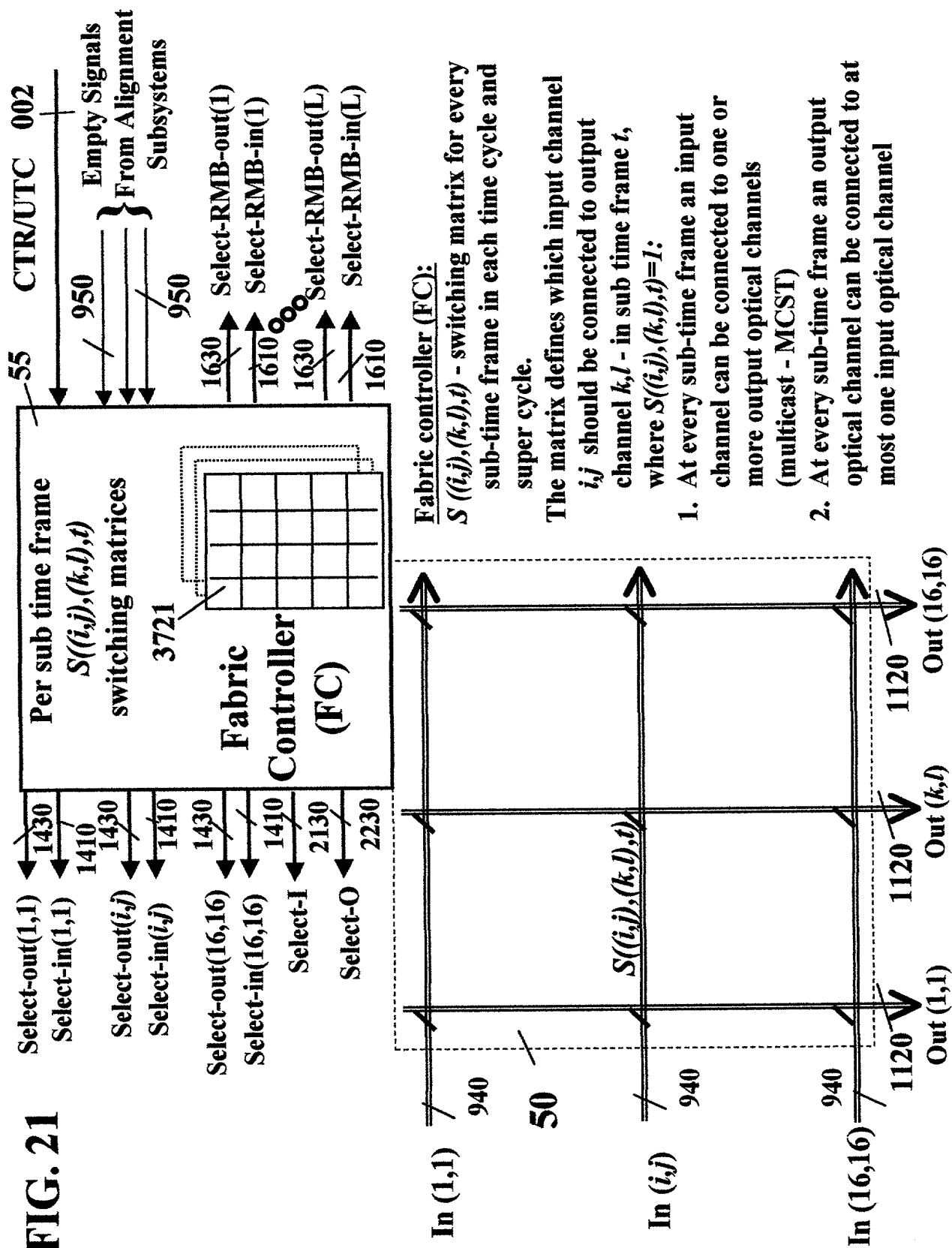
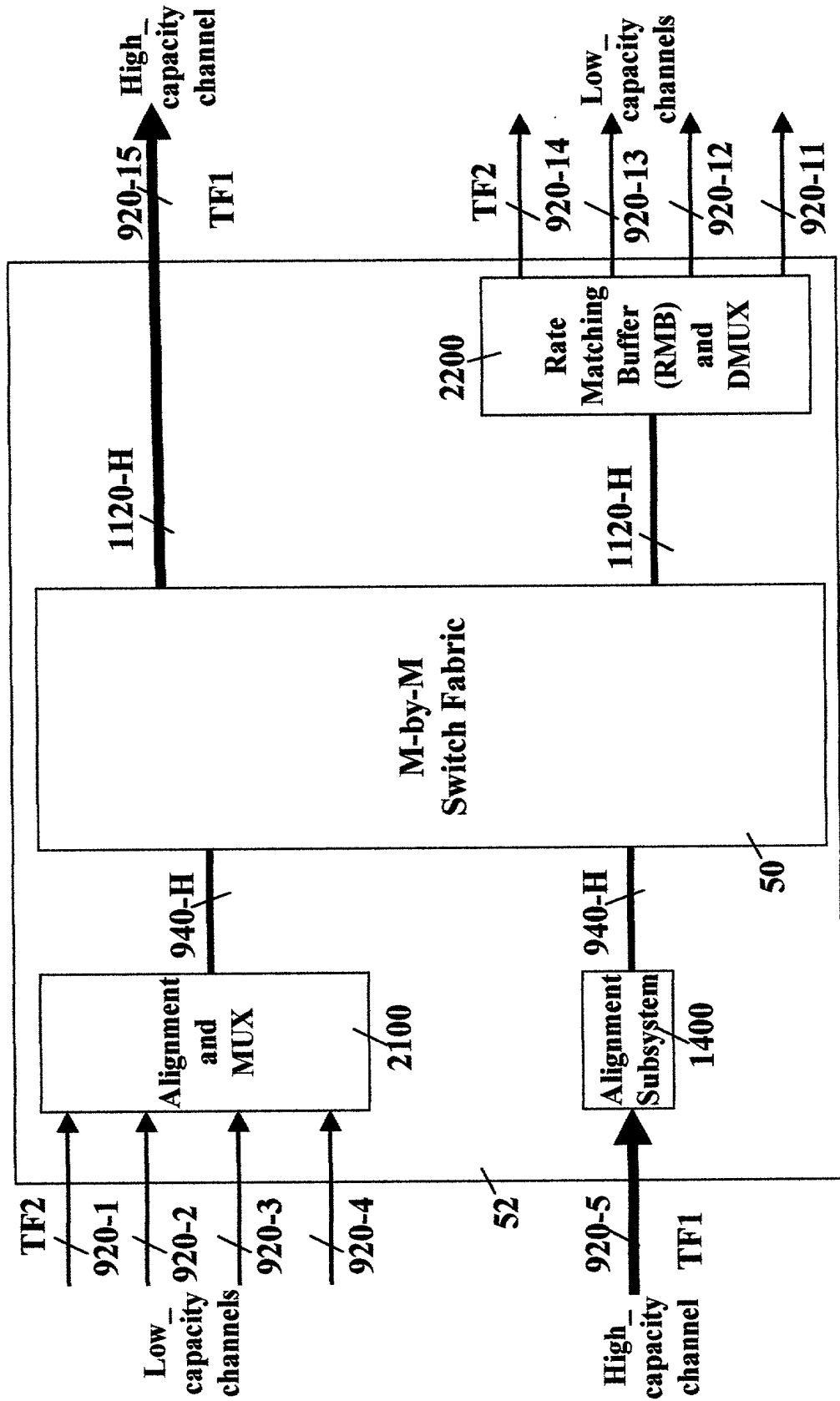


FIG. 22

N: number of input/output channels. E.g., $N=256$
 $M \cdot \text{High_capacity} = N_{\text{high}} \cdot \text{High_capacity} + N_{\text{low}} \cdot \text{Low_capacity}$
 $M < N$



Time Driven Switch

FIG. 23

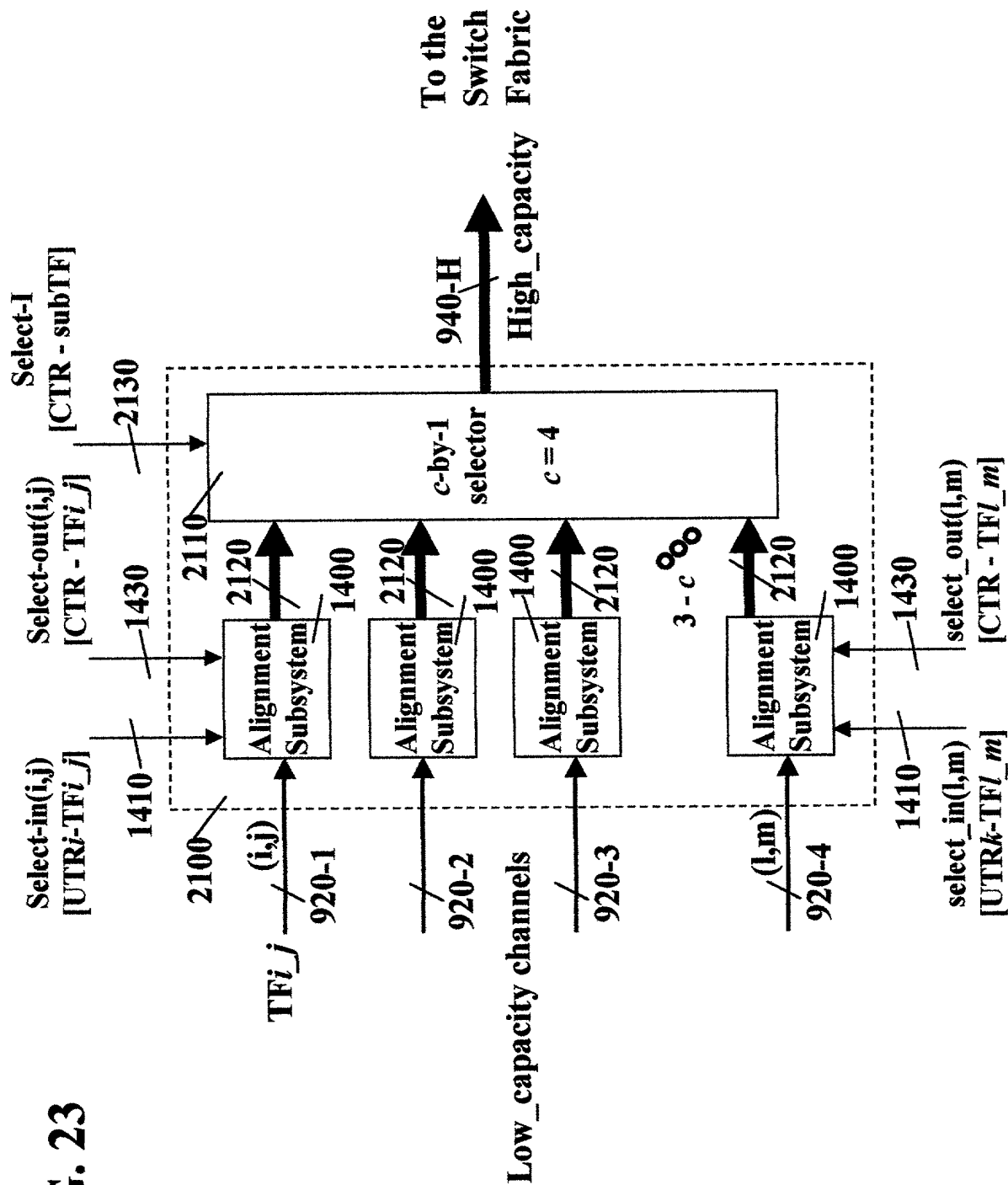


FIG. 24

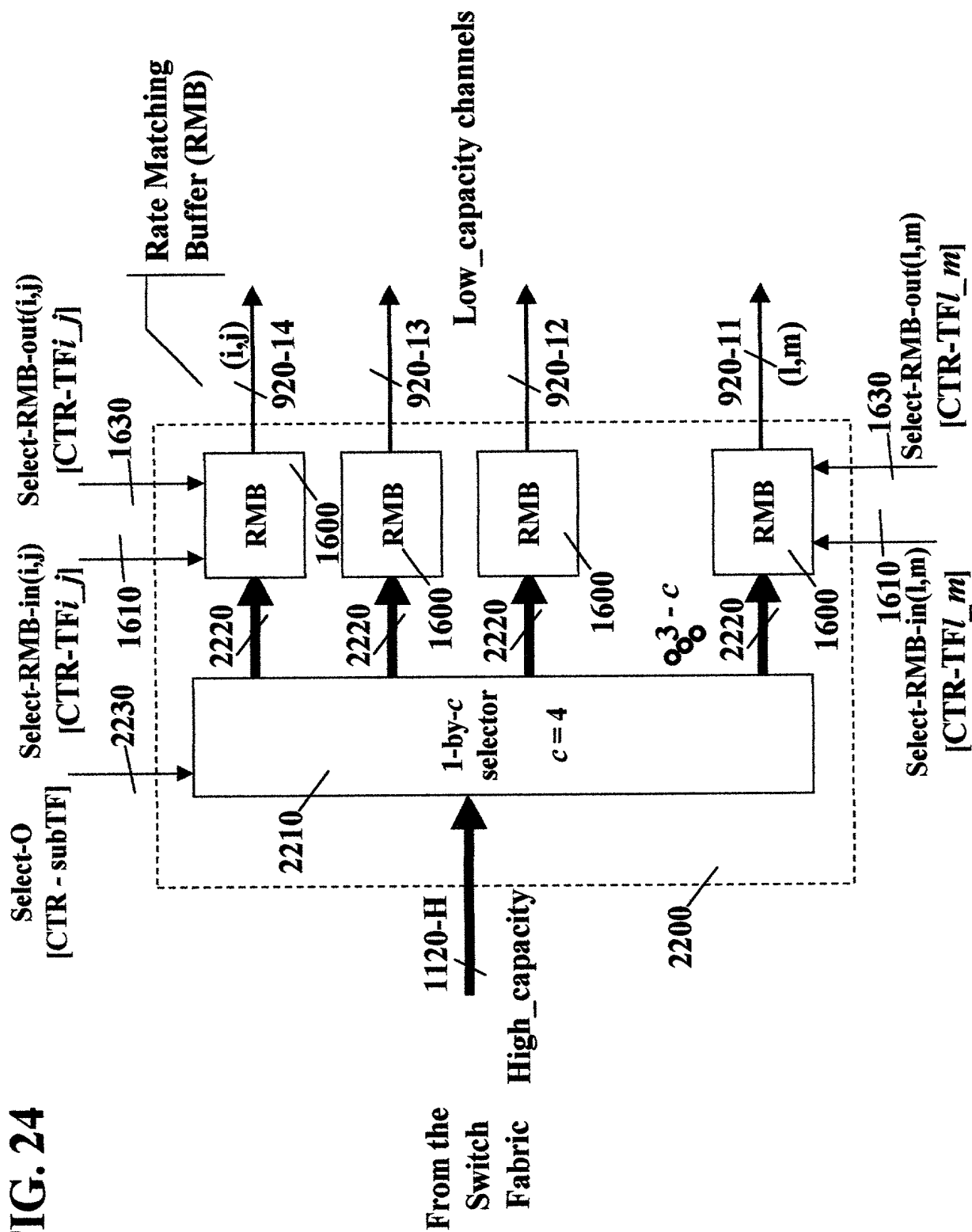
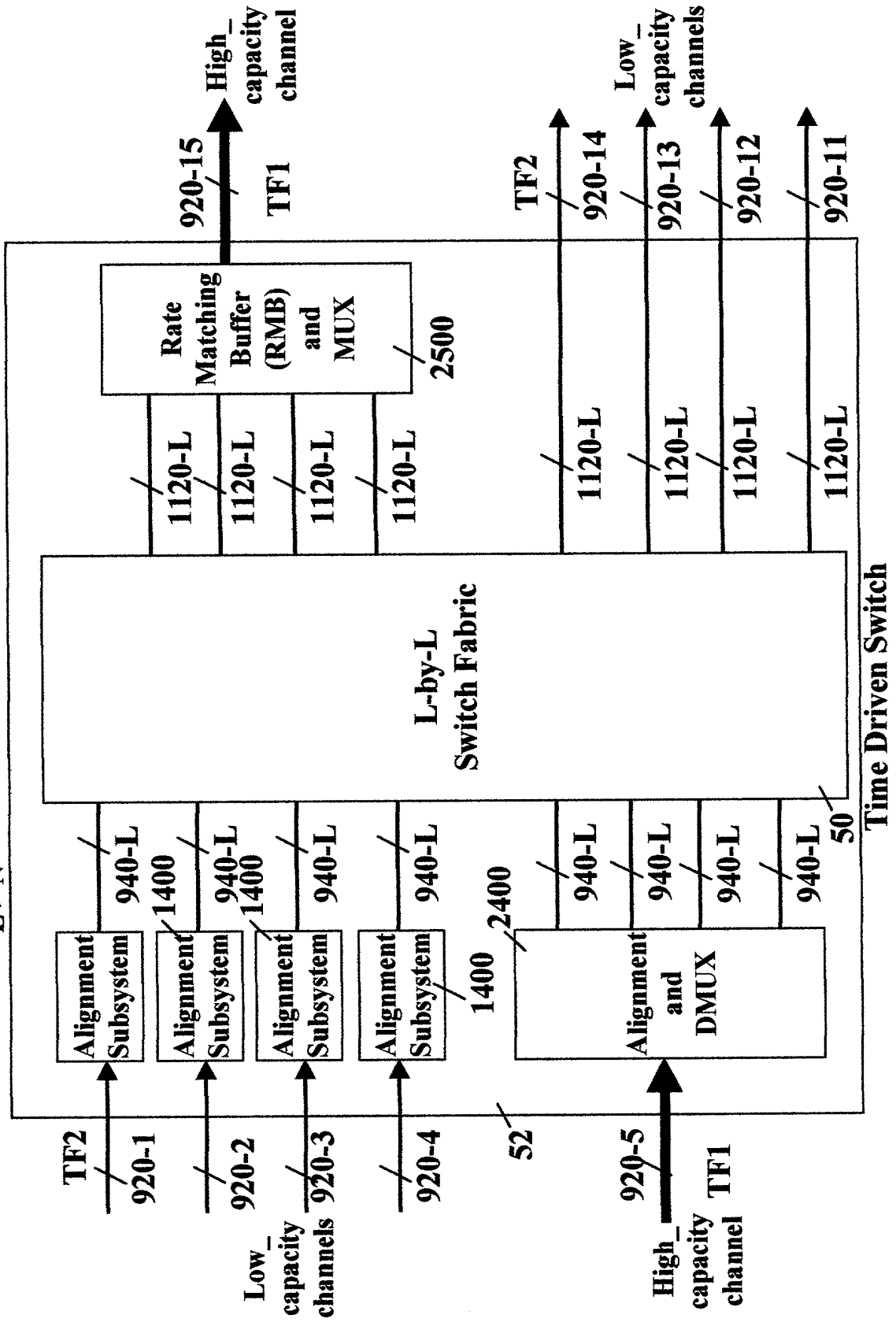


FIG. 25

N: number of input/output channels. E.g., $N=256$
 $L \cdot \text{Low_capacity} = N_{\text{high}} \cdot \text{High_capacity} + N_{\text{low}} \cdot \text{Low_capacity}$
 $L > N$



27

From the Switch Fabric

Rate Matching Buffer (RMB)

Low_capacity

1610 1630 2510 1600

TF2

1120-L

1120-L

1120-L

1120-L

3 - c

c-by-1 selector

c = 4

2110 2230

920-15

2500

Select-RMB-in(i,j) [CTR-TFi_j]

Select-RMB-out(i,j) [CTR-subTF]

Select-RMB-out(i,j) [CTR-TFi_j]

FIG. 28

N: number of input/output channels. E.g., N=256
 L • Low_capacity = N • High_capacity
 L = c • N > N

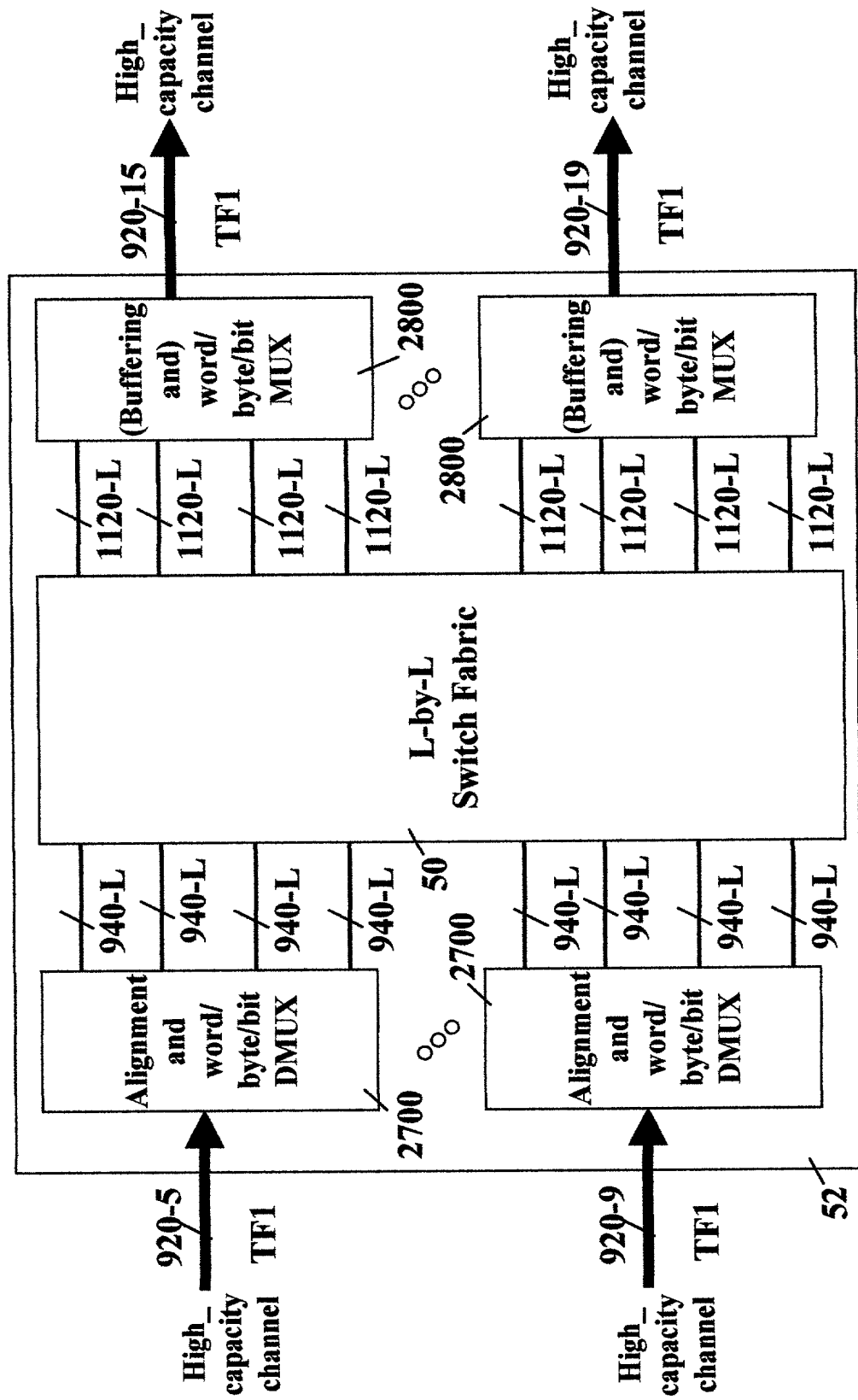
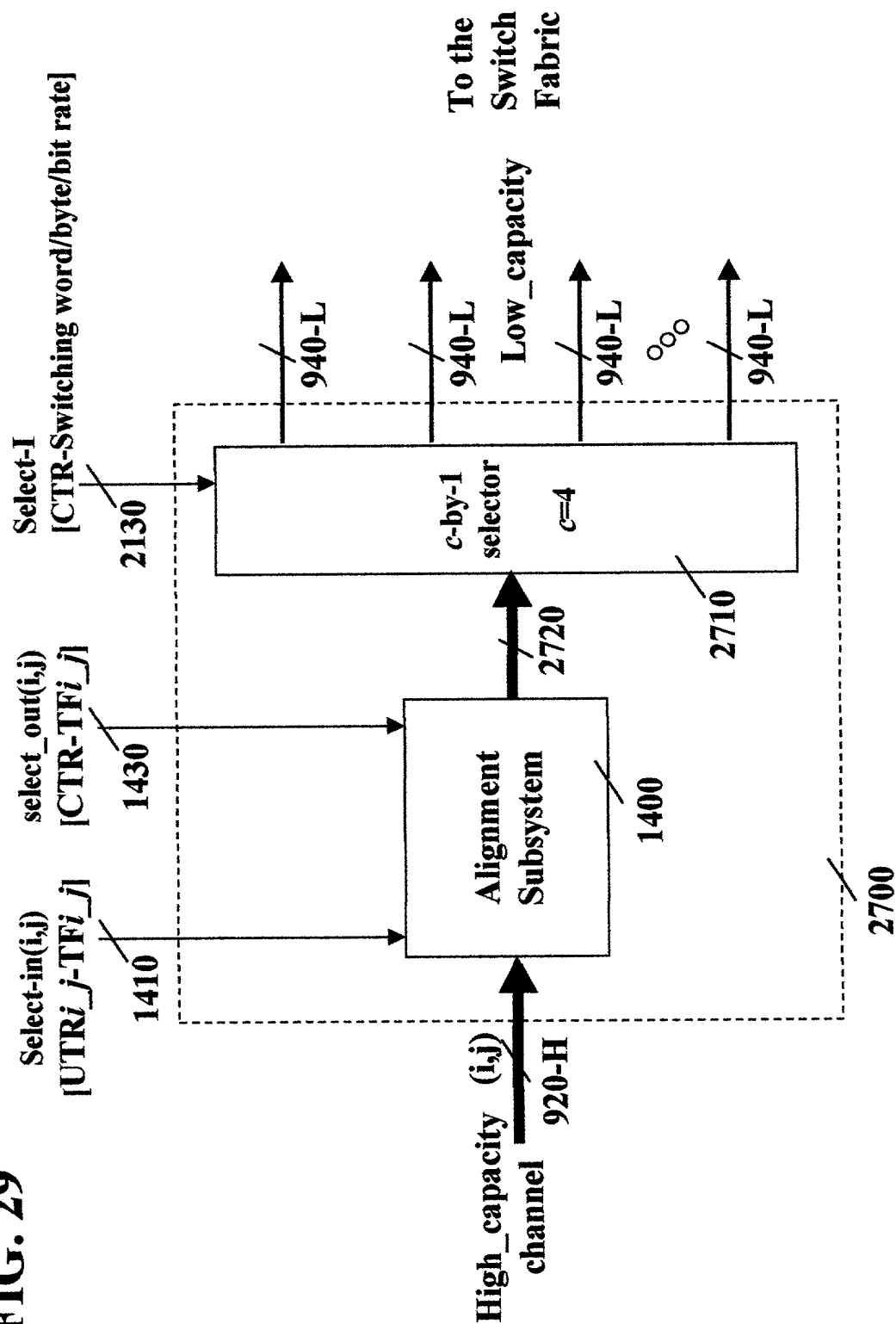


FIG. 29



205770 "FIG. 29" 3660

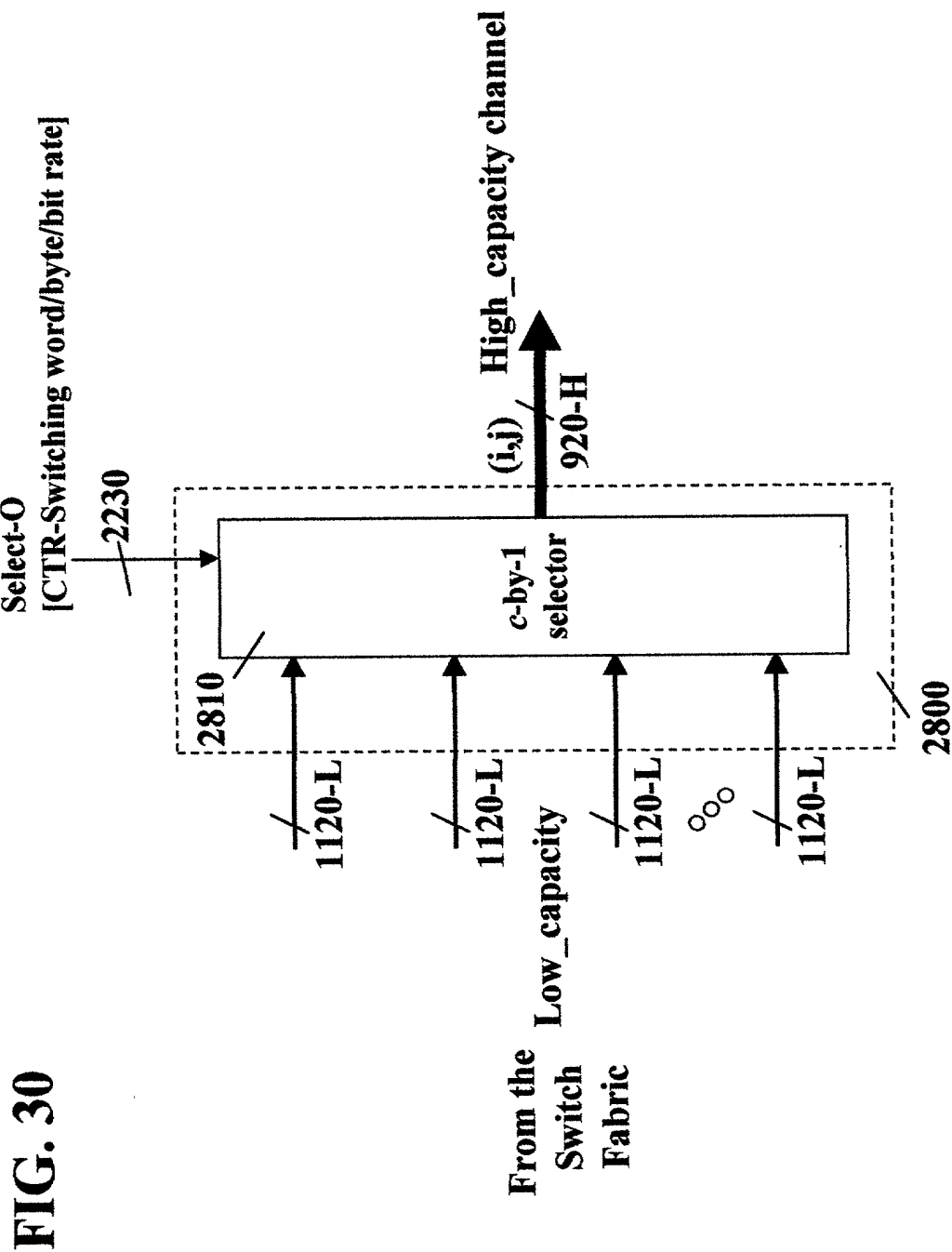
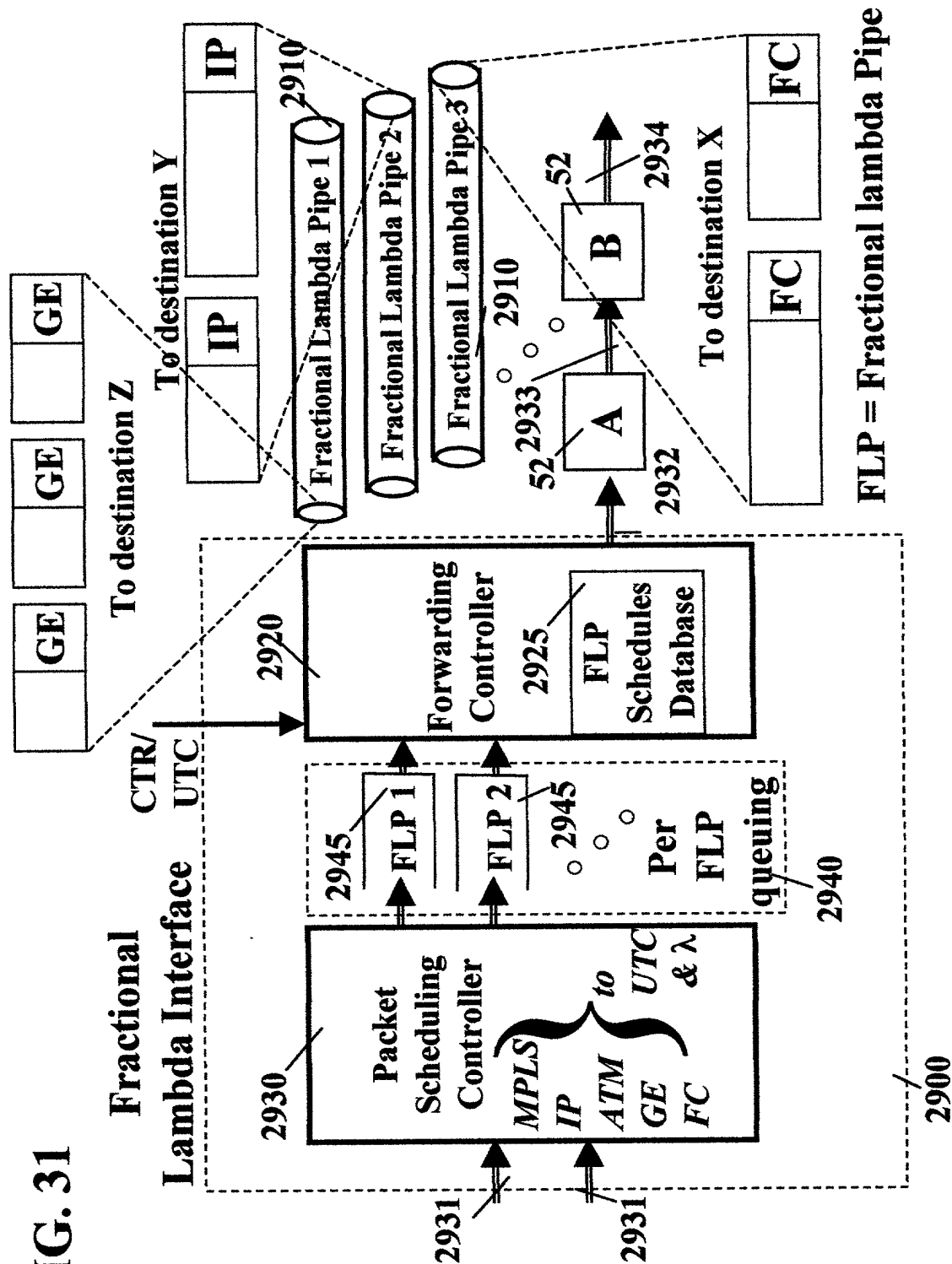


FIG. 31



205770" F80T9650

FIG. 32

Channel Capacity		TF Duration	TF Size	STS-1s	TFs/s
51.84	STS- 1	250	1620	2	4000
		500	3240	4	2000
		1000	6480	8	1000
155.52	STS- 3	125	2430	3	8000
		250	4860	6	4000
		500	9720	12	2000
622.08	STS- 12	62.5	4860	6	16000
		125	9720	12	8000
		250	19440	24	4000
2488.32	STS- 48	62.5	19440	24	16000
		31.25	9720	12	32000
		15.625	4860	6	64000
9953.28	STS- 192	7.8125	9720	12	128000
		15.625	19440	24	64000
1000	GE	125	15625	19.3	8000
		100	12500	15.4	10000
		80	10000	12.3	12500
10000	10GE	15.625	19531.25	24.1	64000
		12.5	15625	19.3	80000
		10	12500	15.4	100000

205FTD" T80T9660

FIG. 33

Ch Capacity		TF Dur.	TF Size	GE TFs	TFs/s
1000	GE	80	10000	1.0	12500
51.84	STS- 1	250	1512	0.15	4000
		500	3024	0.30	2000
		1000	6048	0.60	1000
155.5	STS- 3	125	2268	0.23	8000
		250	4536	0.45	4000
		500	9072	0.91	2000
622.1	STS- 12	62.5	4536	0.45	16000
		125	9072	0.91	8000
		250	18144	1.81	4000
2488	STS- 48	62.5	18144	1.81	16000
		31.25	9072	0.91	32000
		15.625	4536	0.45	64000
9953	STS- 192	7.8125	9072	0.91	128000
		15.625	18144	1.81	64000
10000	10GE	8	10000	1.00	125000
		16	20000	2.00	62500

FIG. 34

Ch Capacity		TF Dur.	TF Size	GE TFs	TFs/s
1000	GE	62.5	7812.5	1.0	16000
51.84	STS- 1	250	1512	0.19	4000
		500	3024	0.39	2000
		1000	6048	0.77	1000
155.52	STS- 3	125	2268	0.29	8000
		250	4536	0.58	4000
		500	9072	1.16	2000
622.08	STS- 12	62.5	4536	0.58	16000
		125	9072	1.16	8000
		250	18144	2.32	4000
2488.32	STS- 48	62.5	18144	2.32	16000
		31.25	9072	1.16	32000
		15.625	4536	0.58	64000
9953.28	STS- 192	7.8125	9072	1.16	128000
		15.625	18144	2.32	64000
10000	10GE	12.5	15625	2.00	80000
		25	31250	4.00	40000

205FTD" T80T9660

FIG. 35

TF Alignment of UTR(i) to UTC - with three input queues - principle of operation:

The same queue is not used simultaneously for:

1. Receiving data packets from the serial link, and
2. Forwarding data packets to the switch

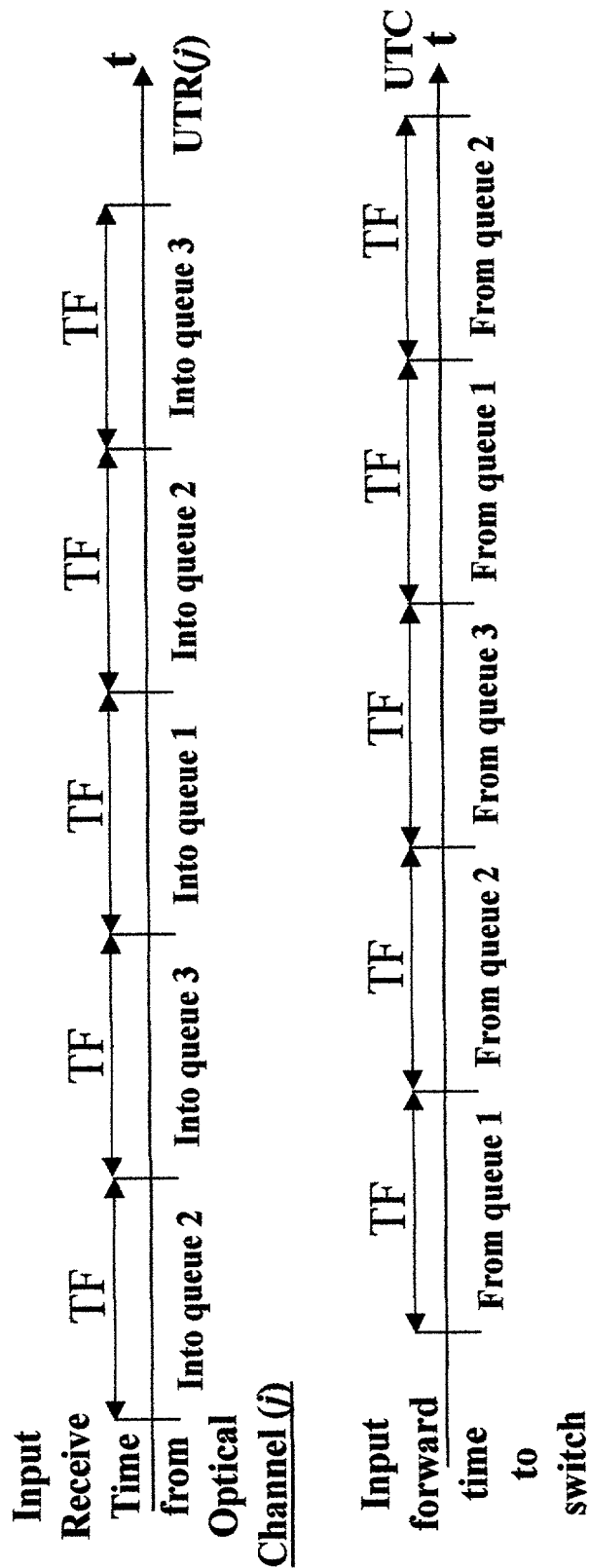


FIG. 36

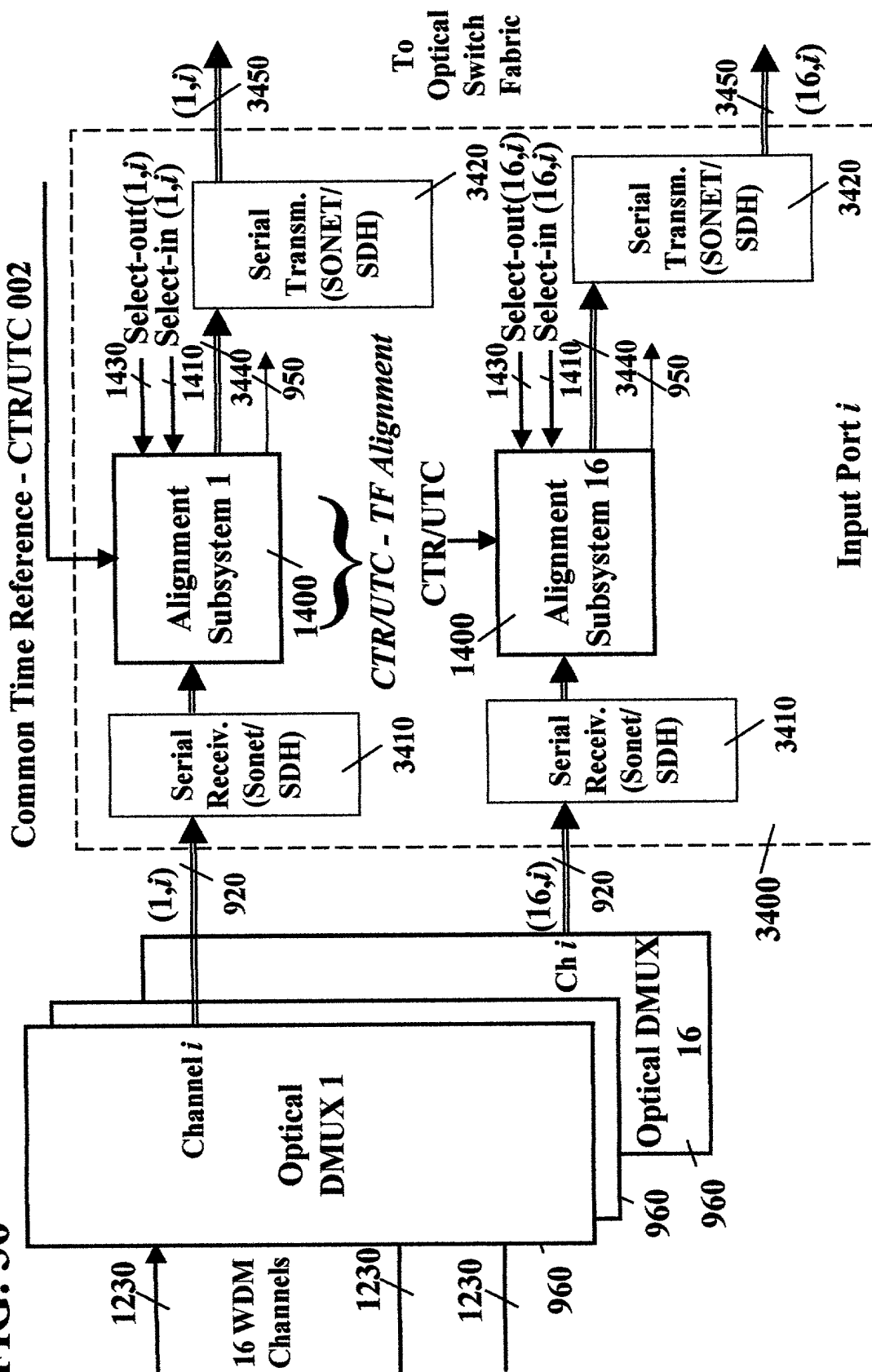
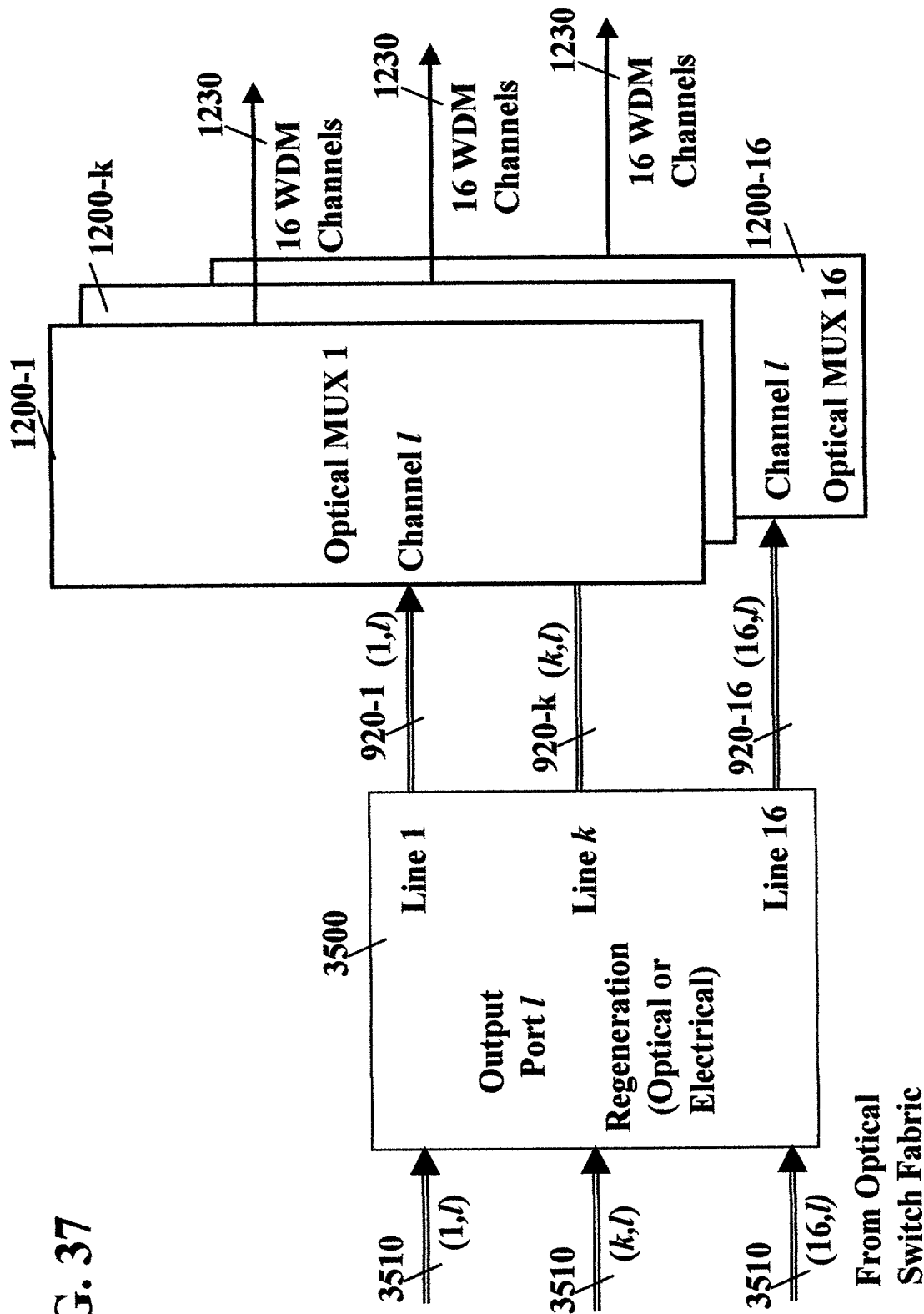


FIG. 37



205700-18079560

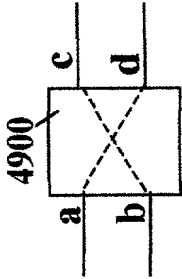


FIG. 38A

Straight Connection of a
2-by-2 Optical Switching Block Cross Connection of a
2-by-2 Optical Switching Block

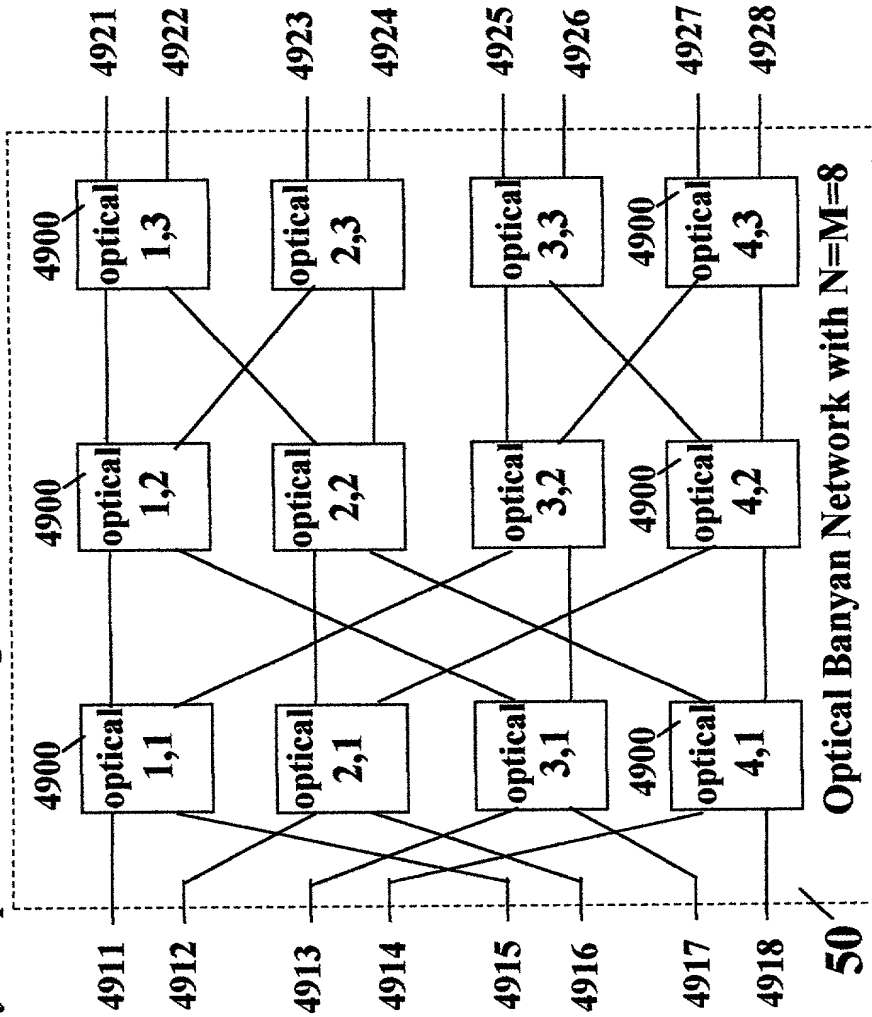
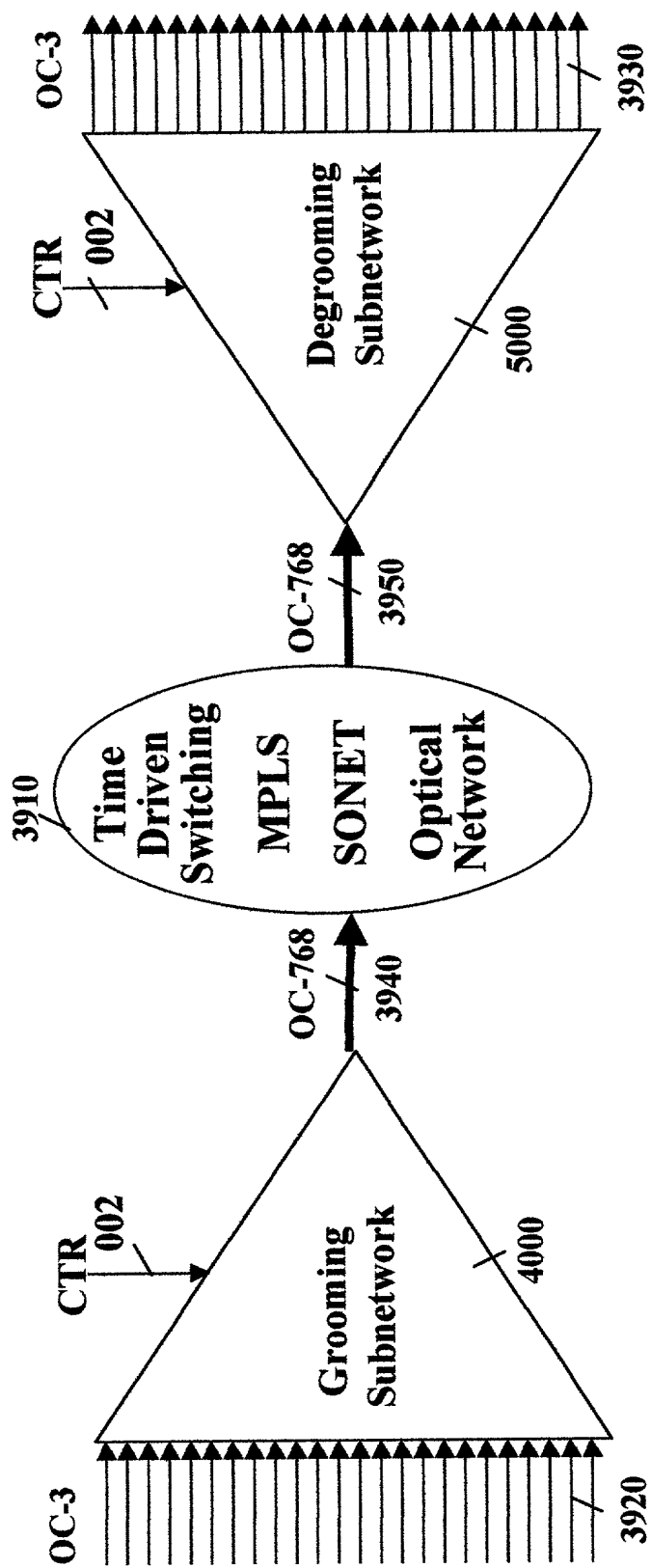


FIG. 38C

FIG. 39



205110 "T80T9660

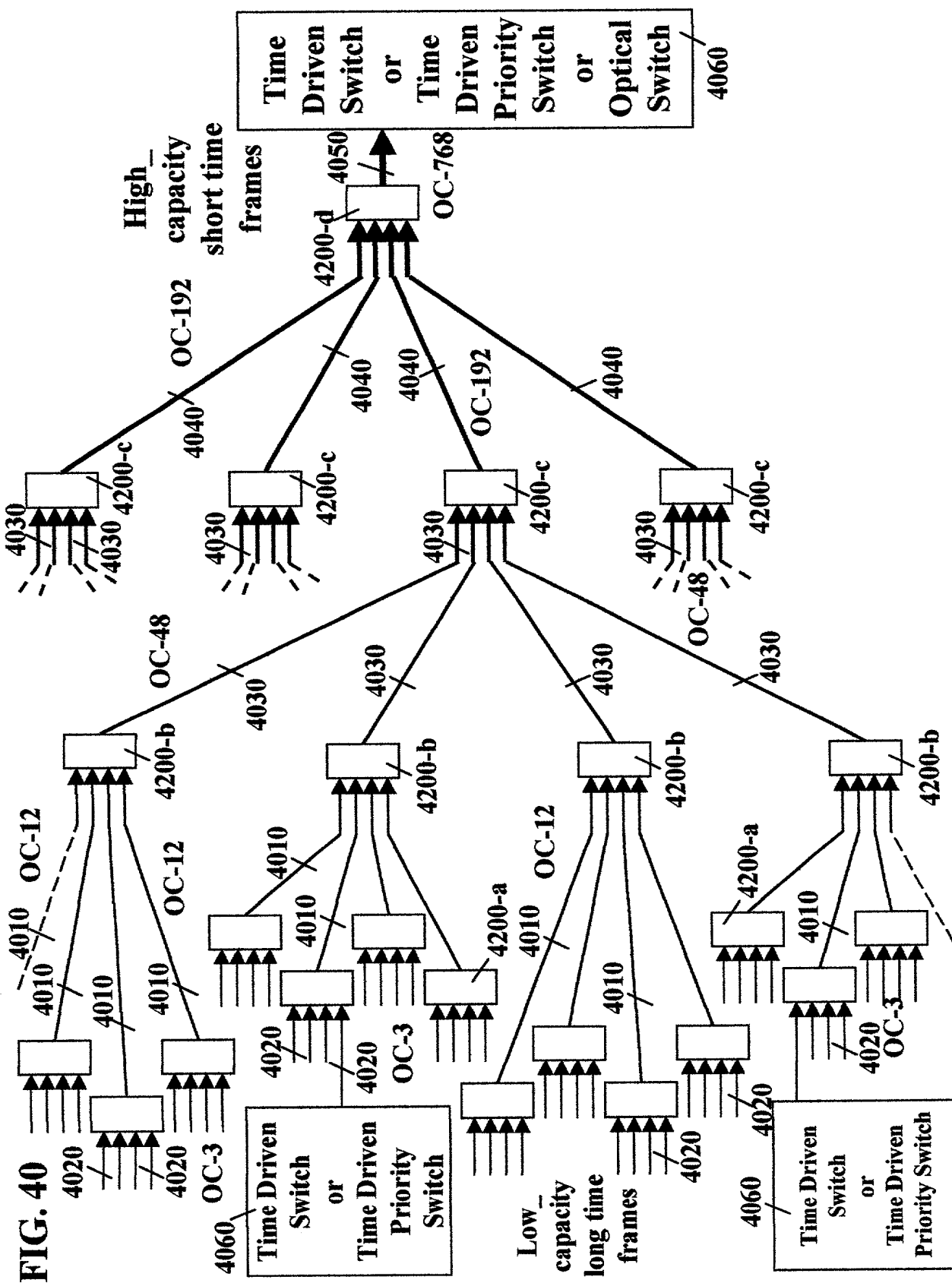




FIG. 41B

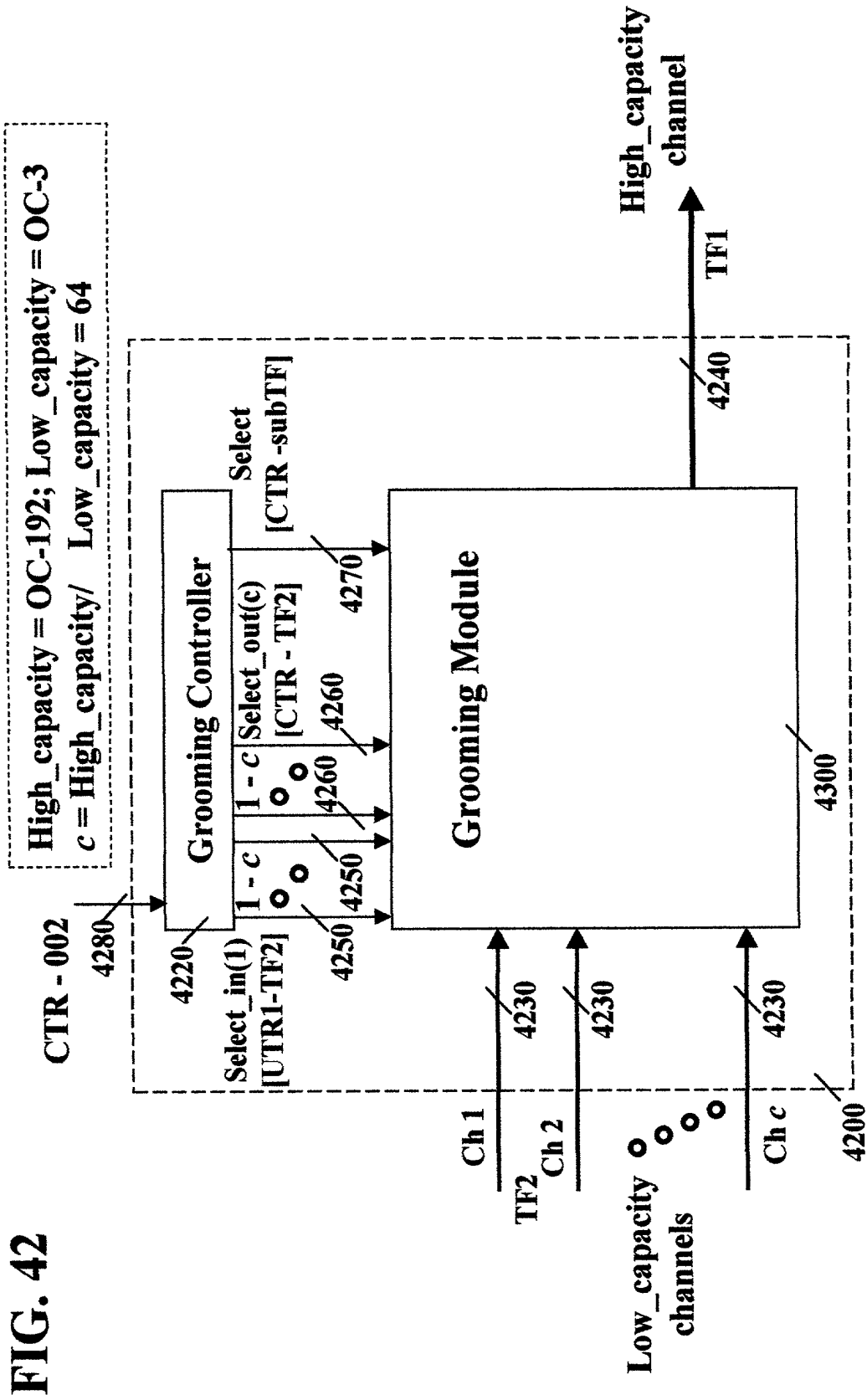
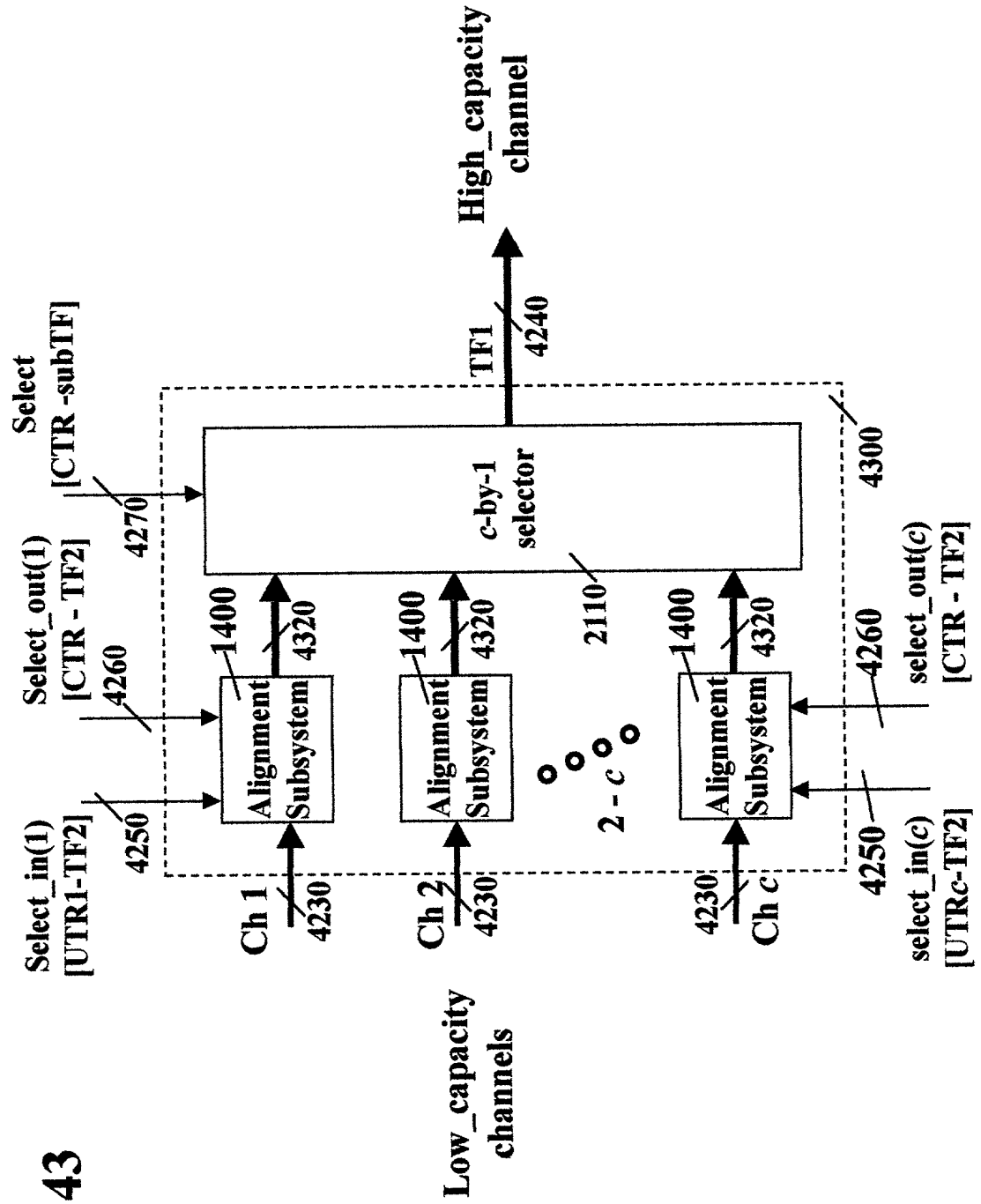


FIG. 43



205710" F80T9650

FIG. 44

- $CC1_length \cdot TF1 = CC2_length \cdot TF2 = CC3_length \cdot TF2$
- $TF2 = (SC1_length / SC2_length) \cdot TF1 = k \cdot TF1$, where the common cycles of $TF1$ and $TF2$ are aligned with respect to UTC.

For $k = 2$ and $c = 4$ (e.g., High_capacity=OC-192, Low_capacity=OC-48):

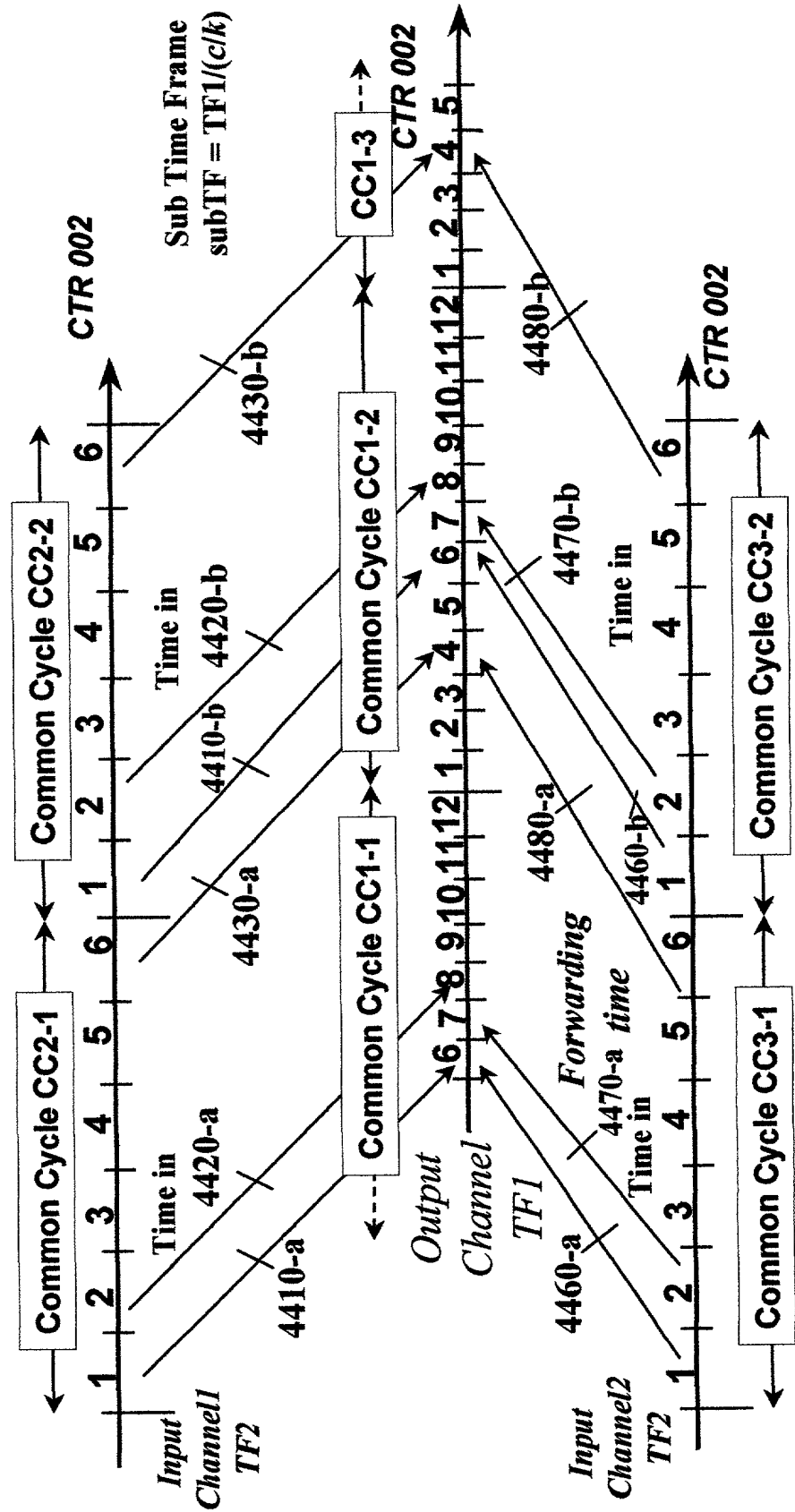
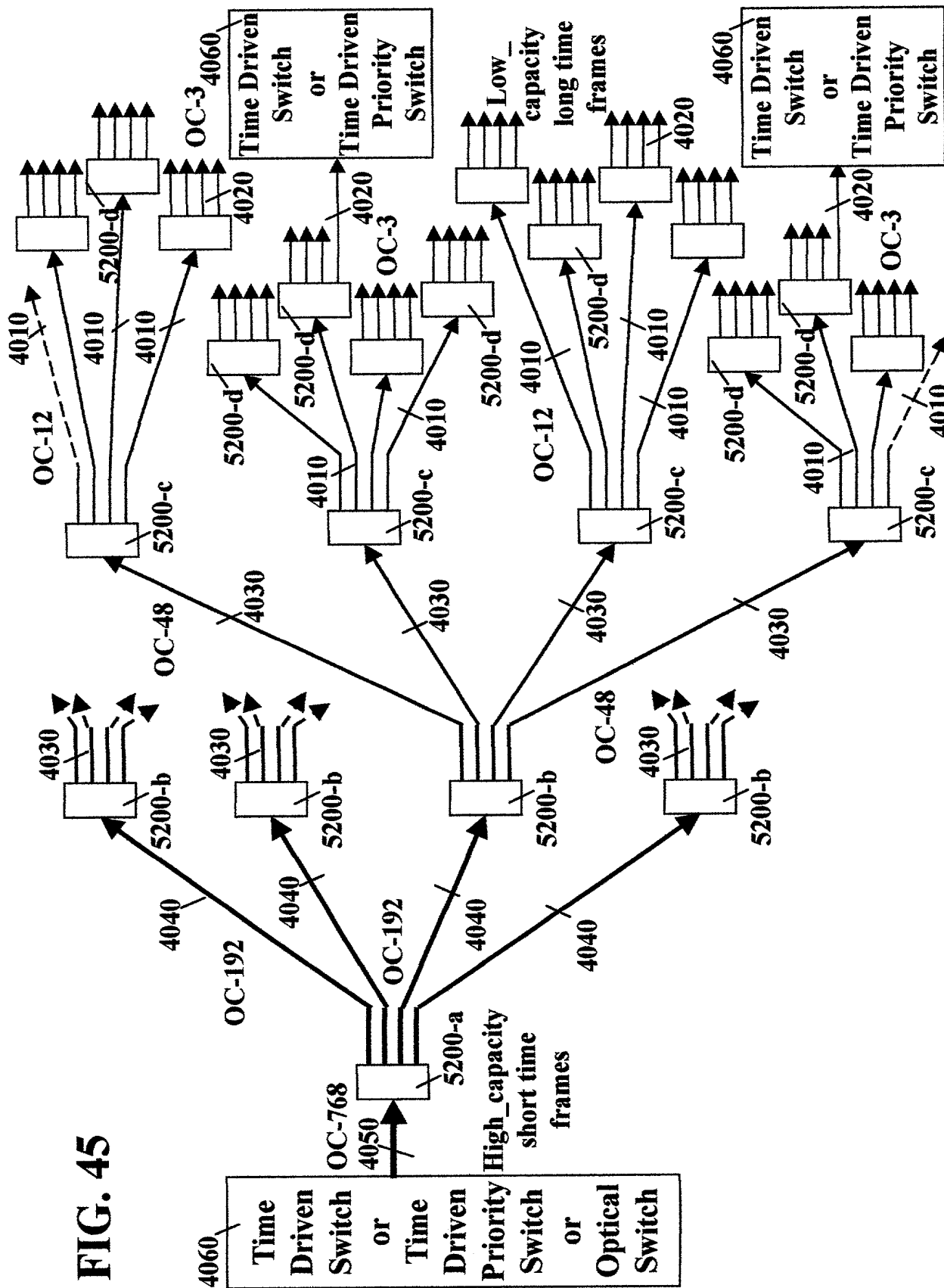
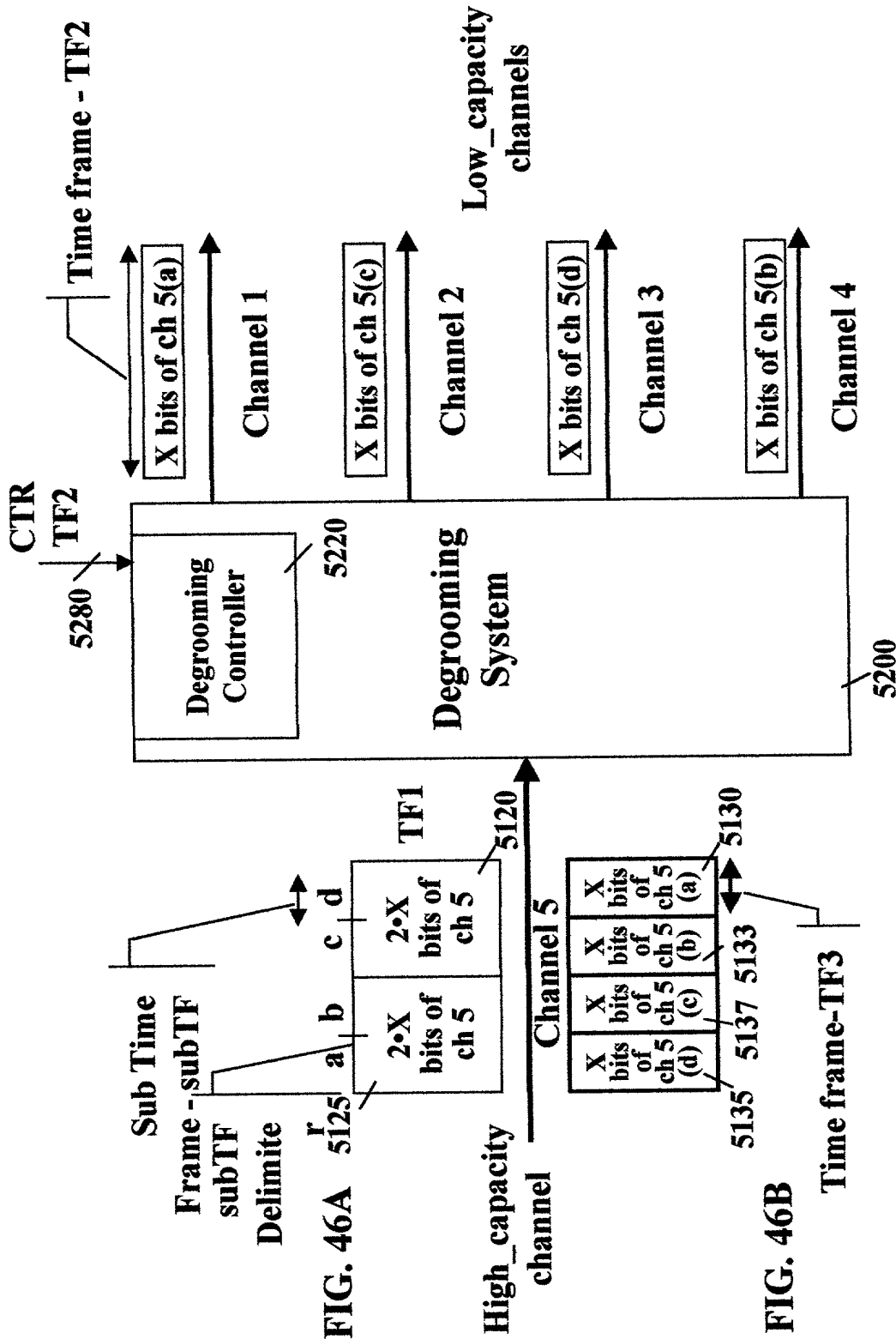


FIG. 45





$c=4$, e.g., OC-192/OC-48
 $k=2$, e.g., 25 microsec/12.5 microsec

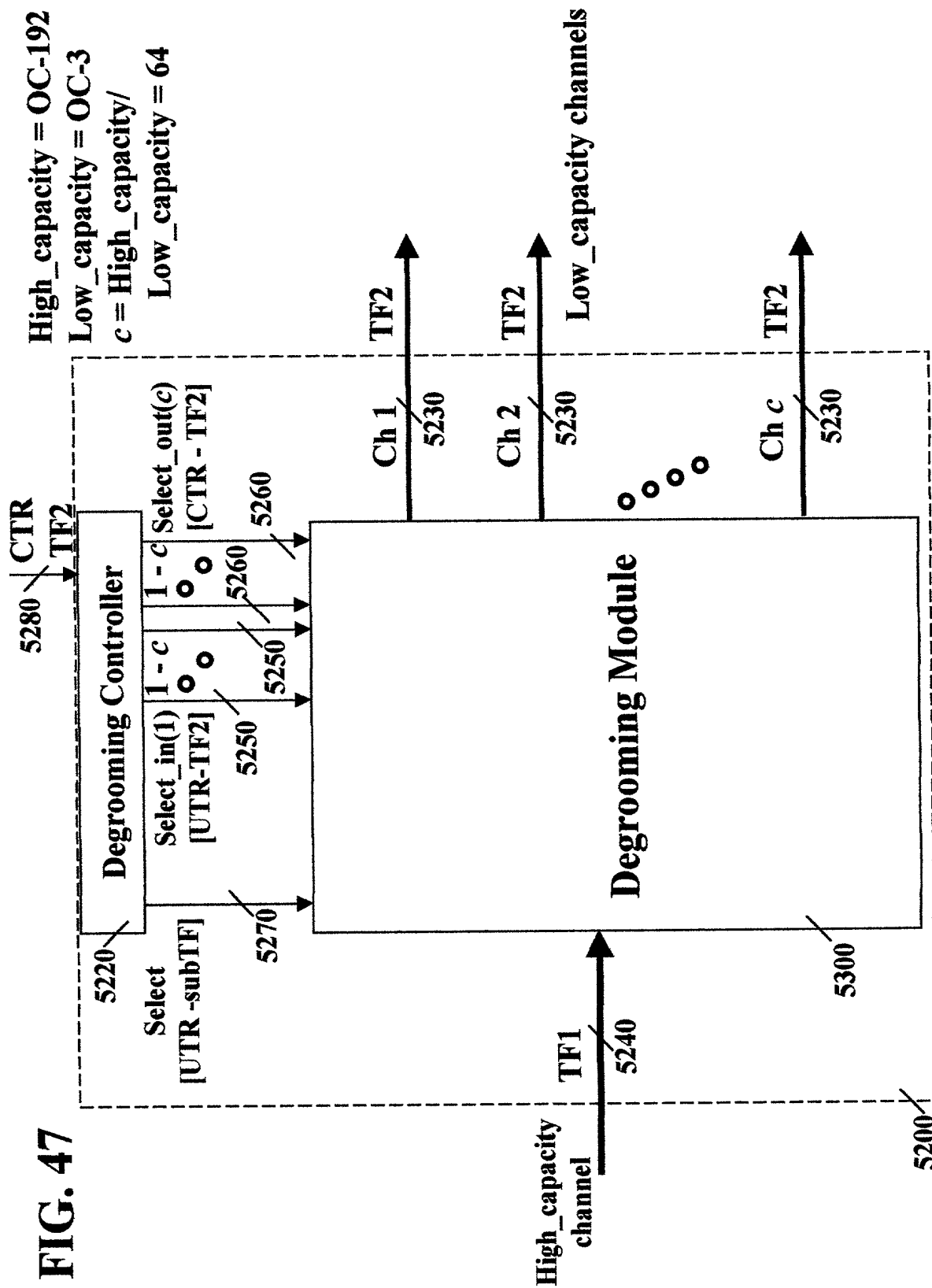
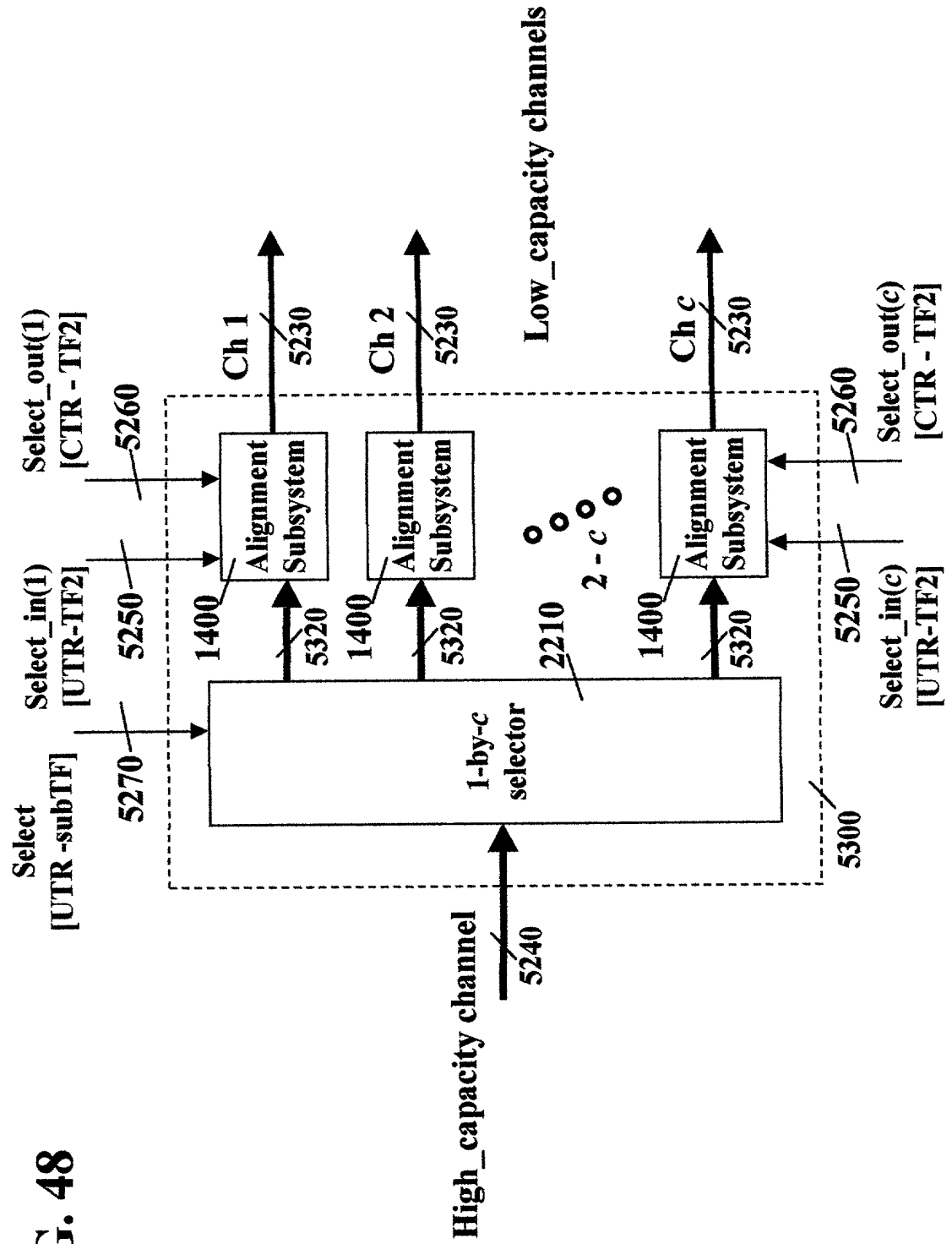


FIG. 48



205710" T80T9660

FIG. 49

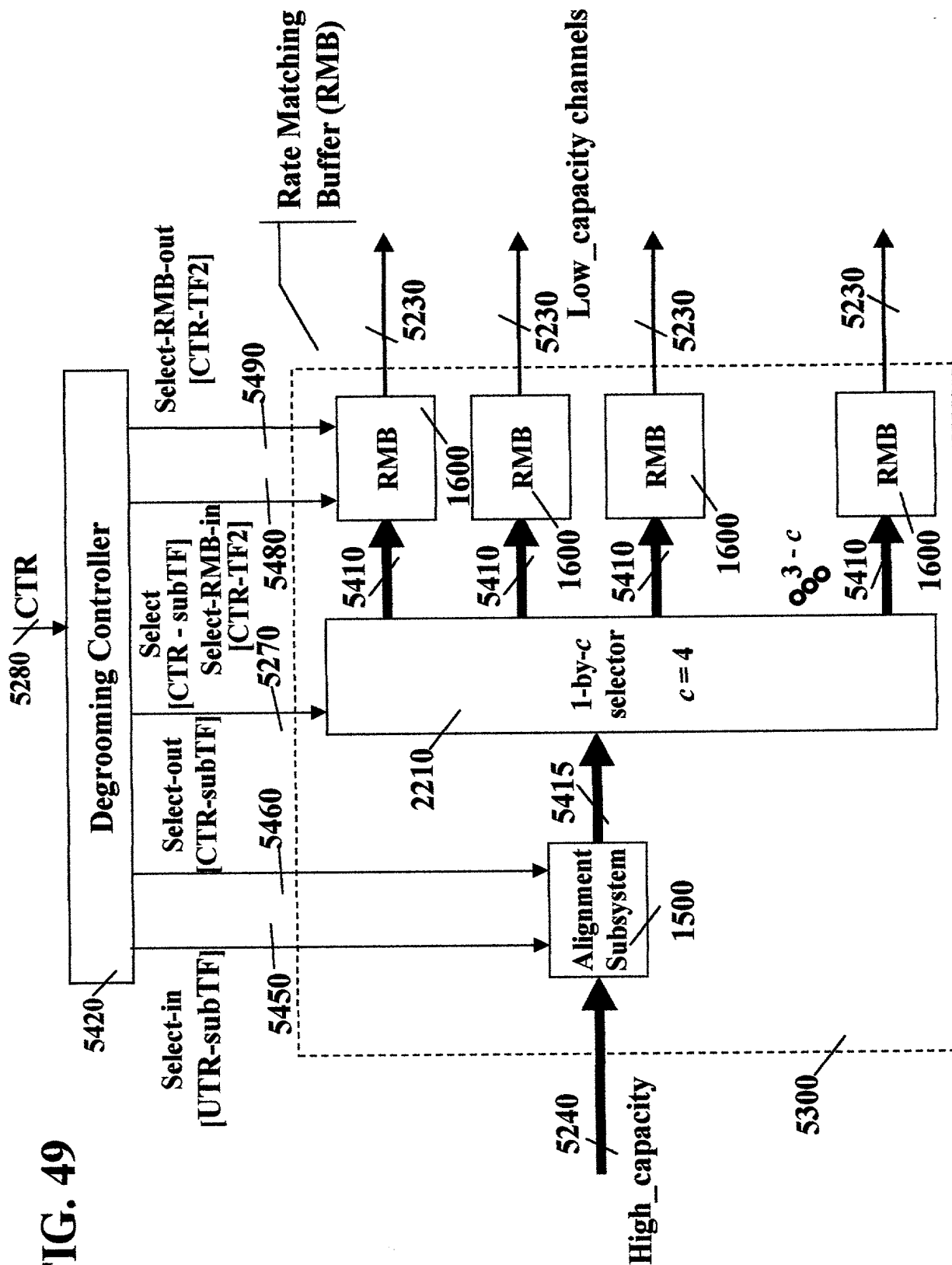


FIG. 50

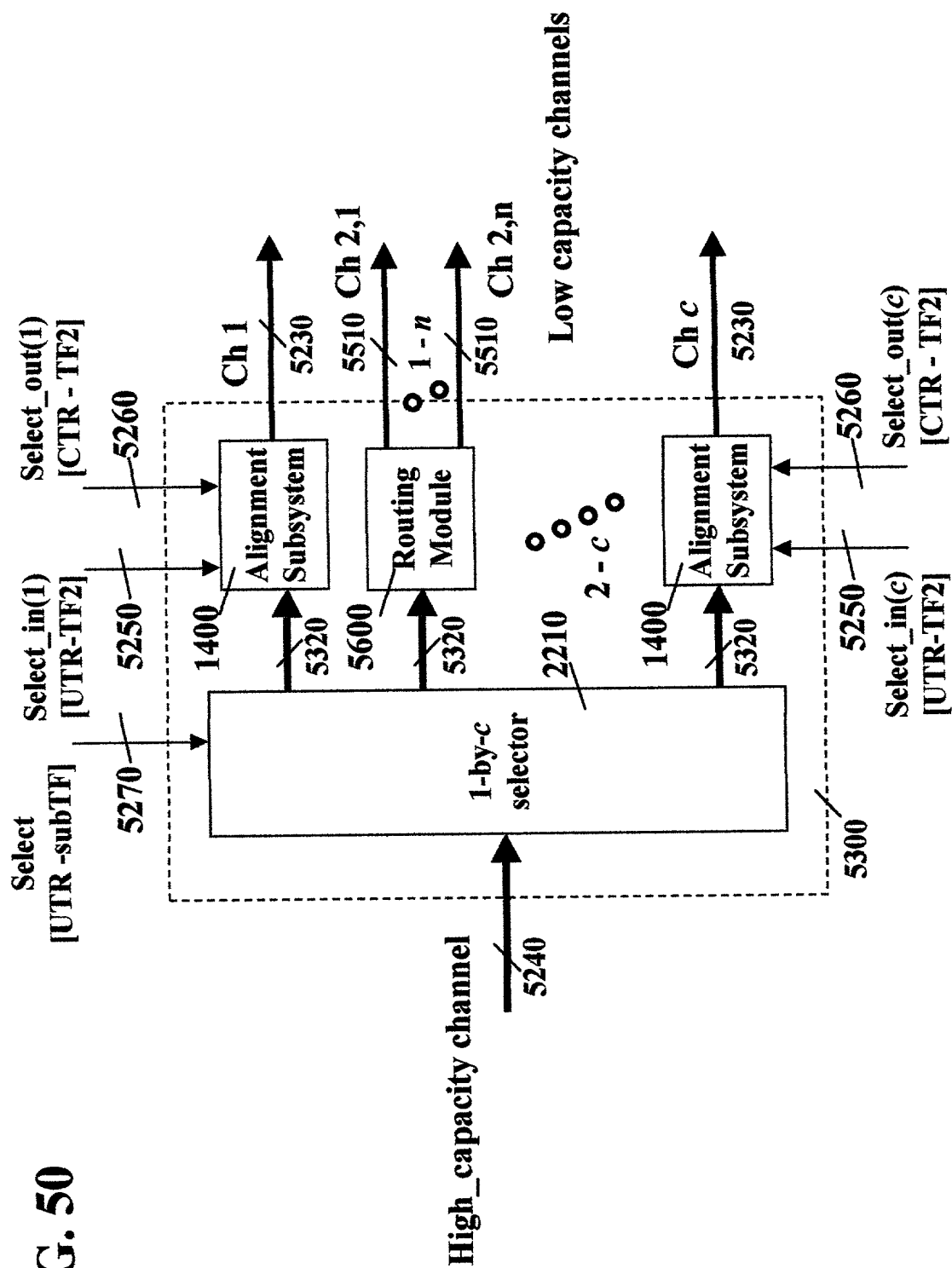
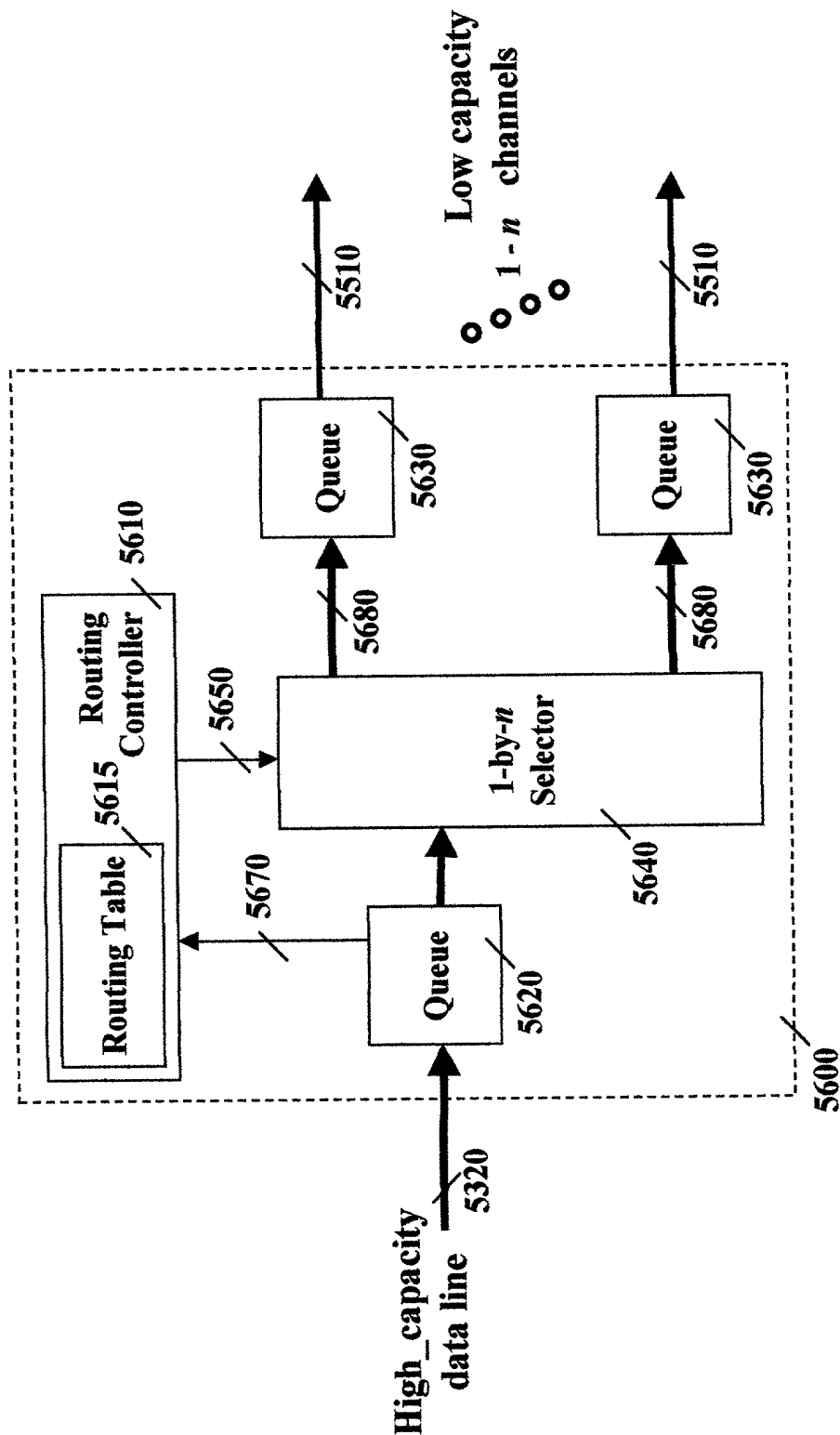


FIG. 51



- FIG. 52**
- $CC1_length \cdot TF1 = CC2_length \cdot TF2 = CC3_length \cdot TF2$
 - $TF2 = (SC1_length / SC2_length) \cdot TF1 = k \cdot TF1$, where the common cycles of $TF1$ and $TF2$ are aligned with respect to UTC.
- For $k = 2$ and $c = 4$ (e.g., High_capacity=OC-192, Low_capacity=OC-48):

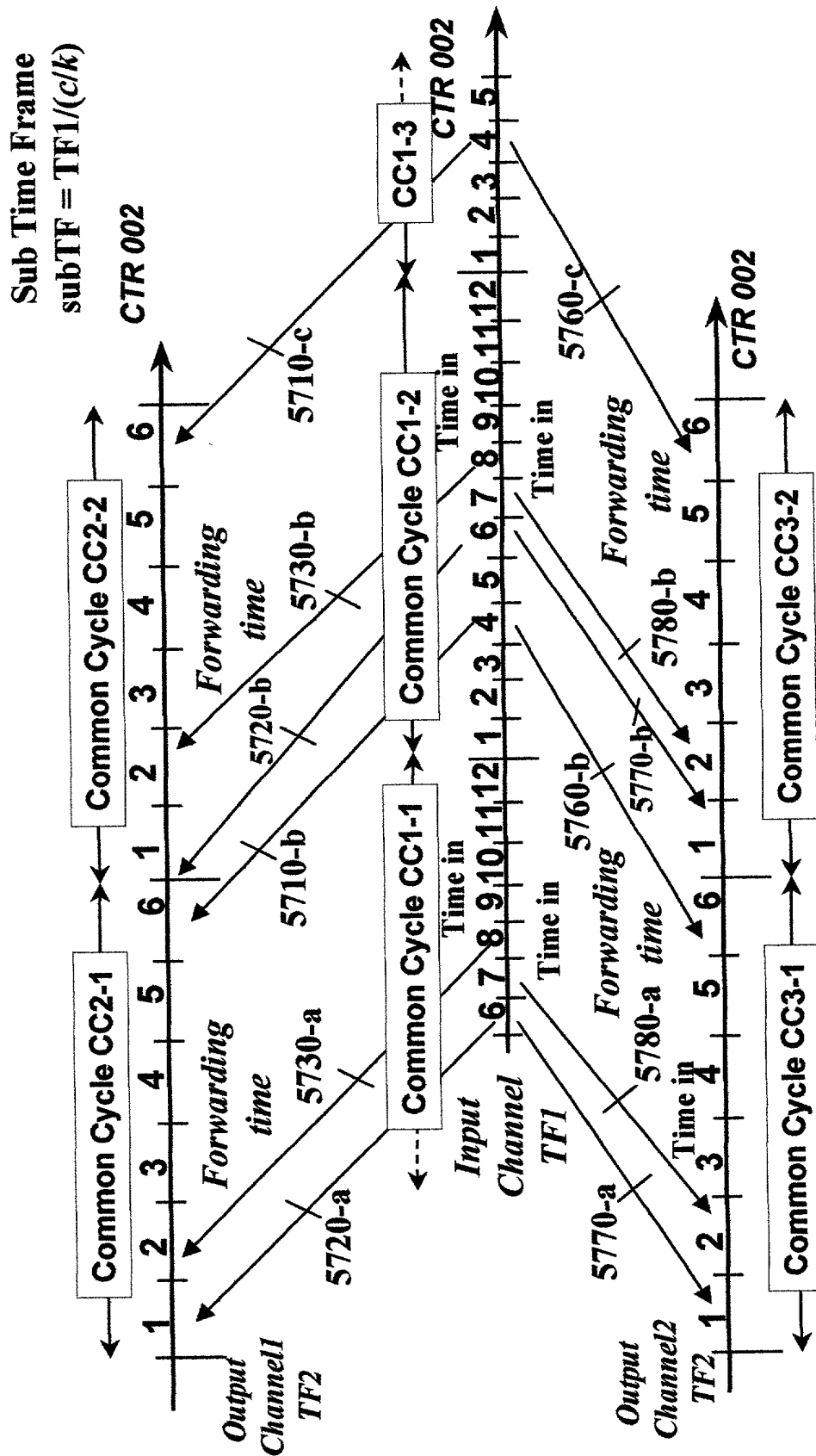
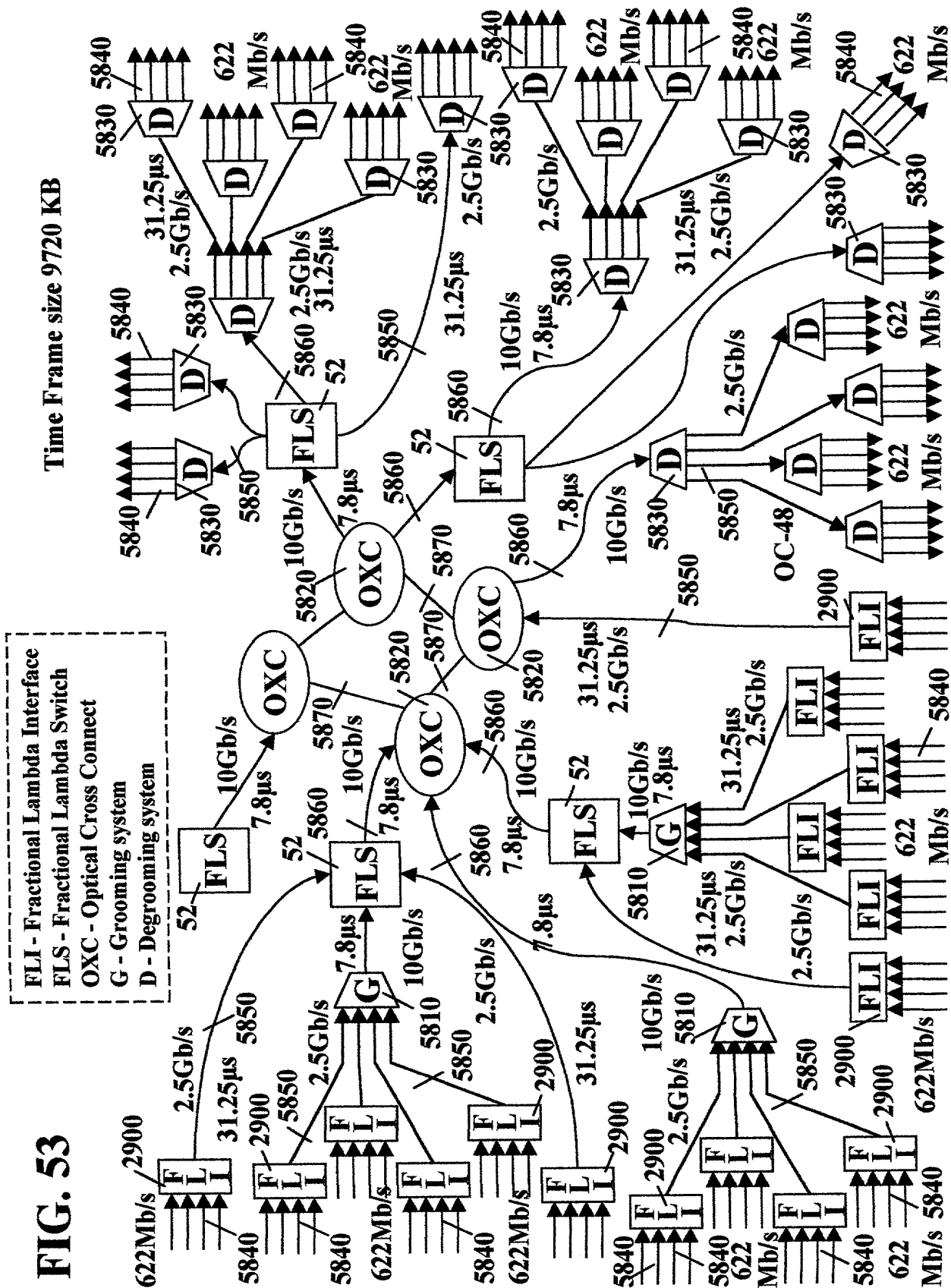
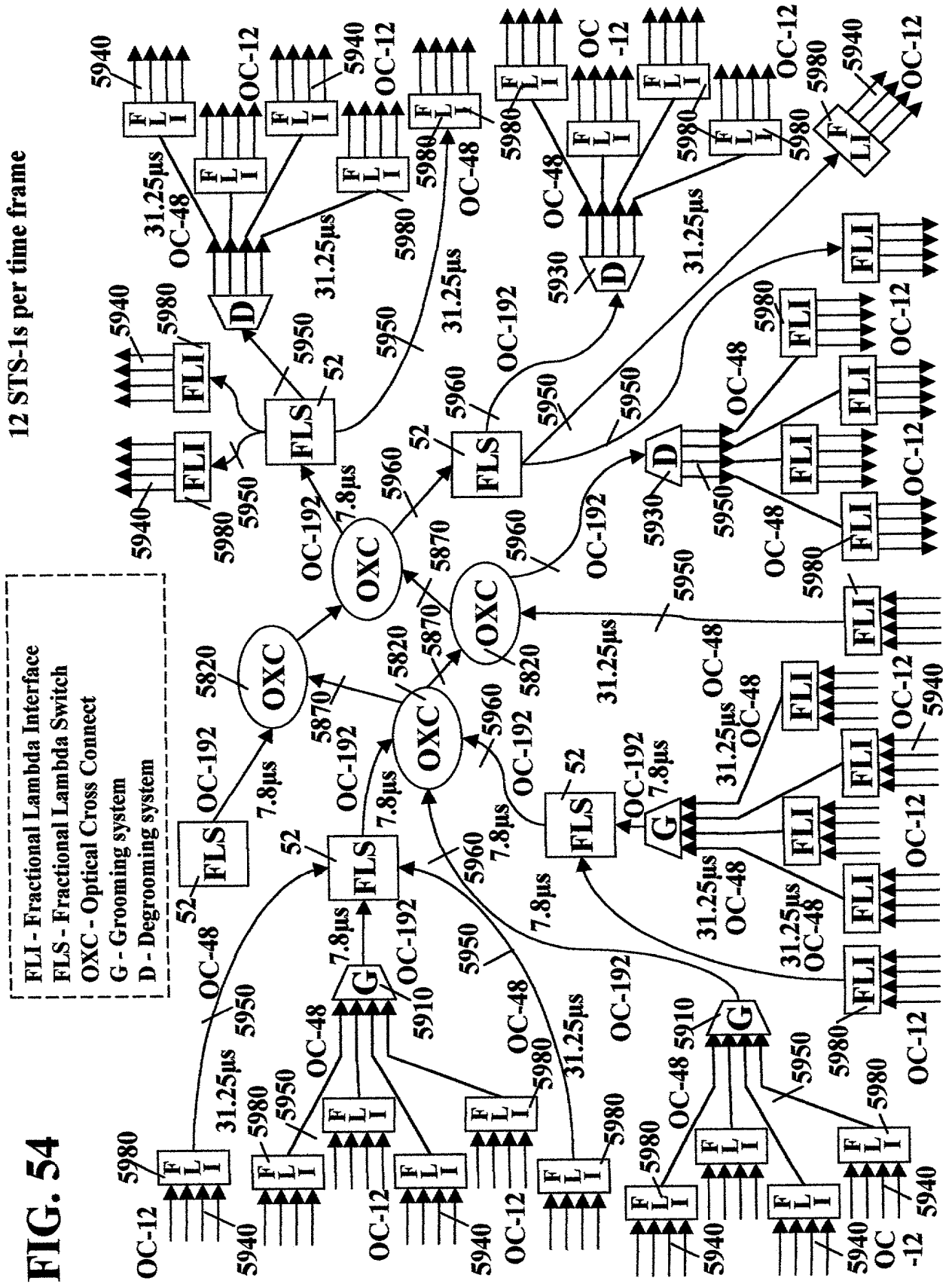
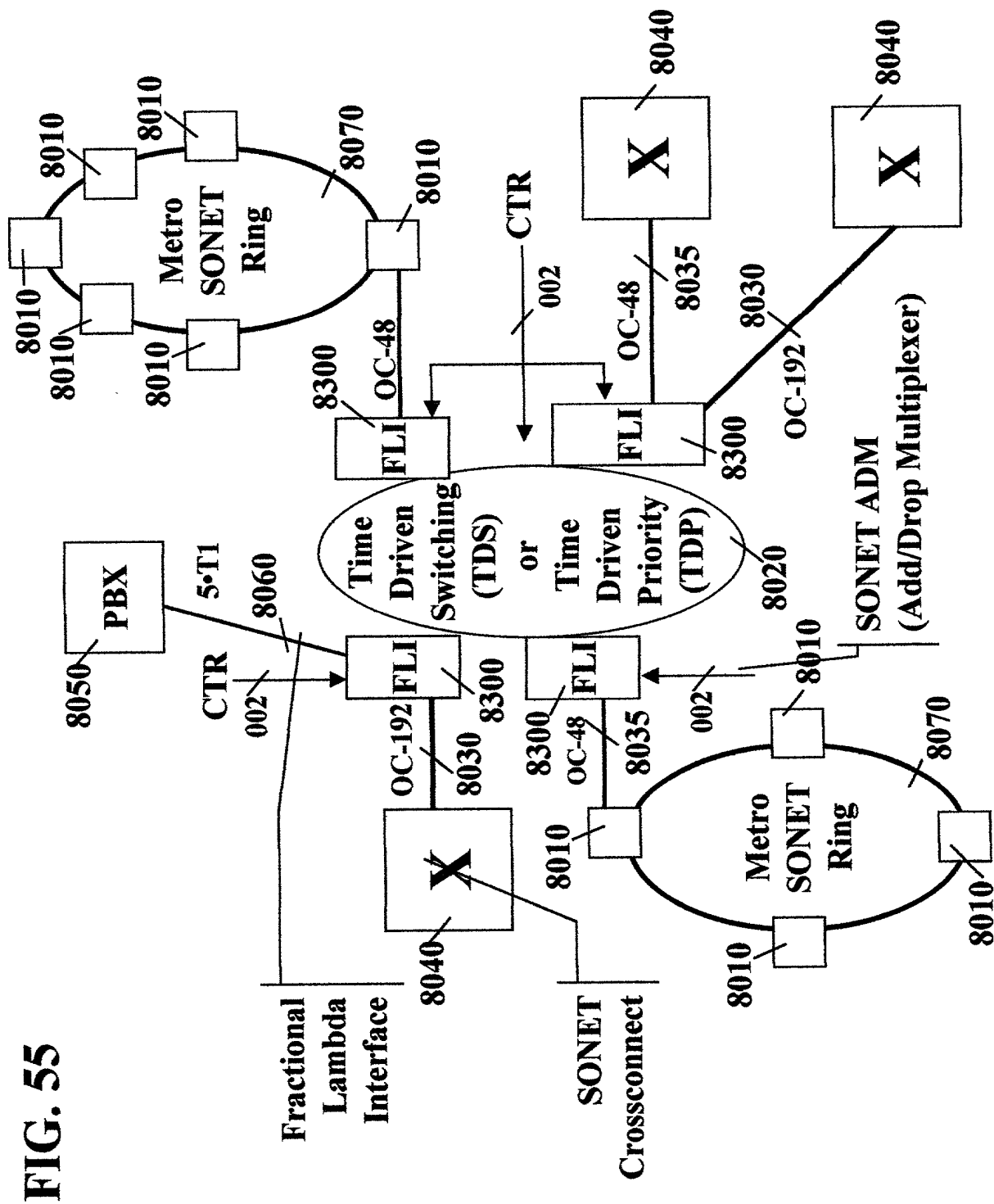


FIG. 53



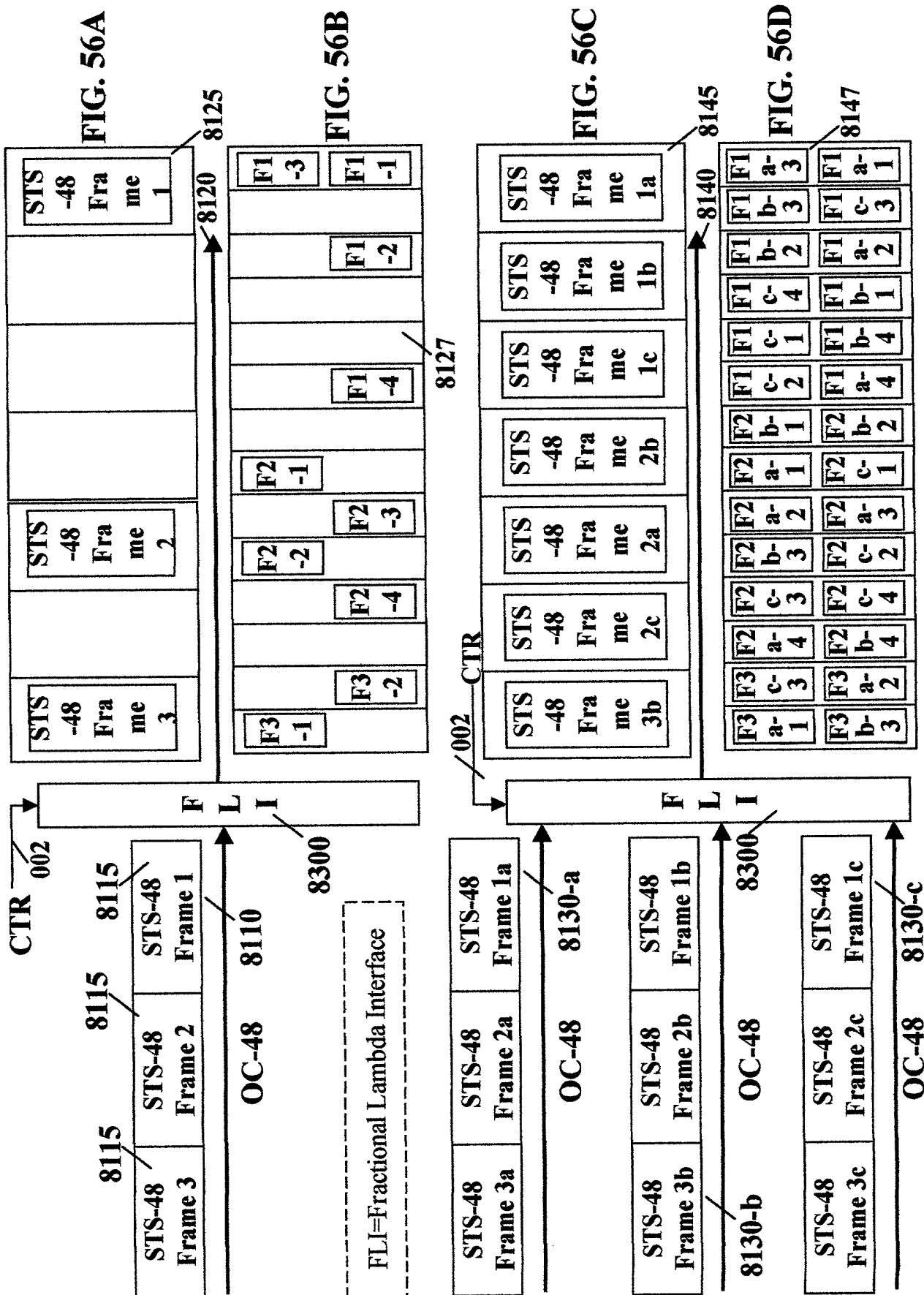
205 F.T.O. T80T91560

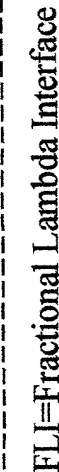


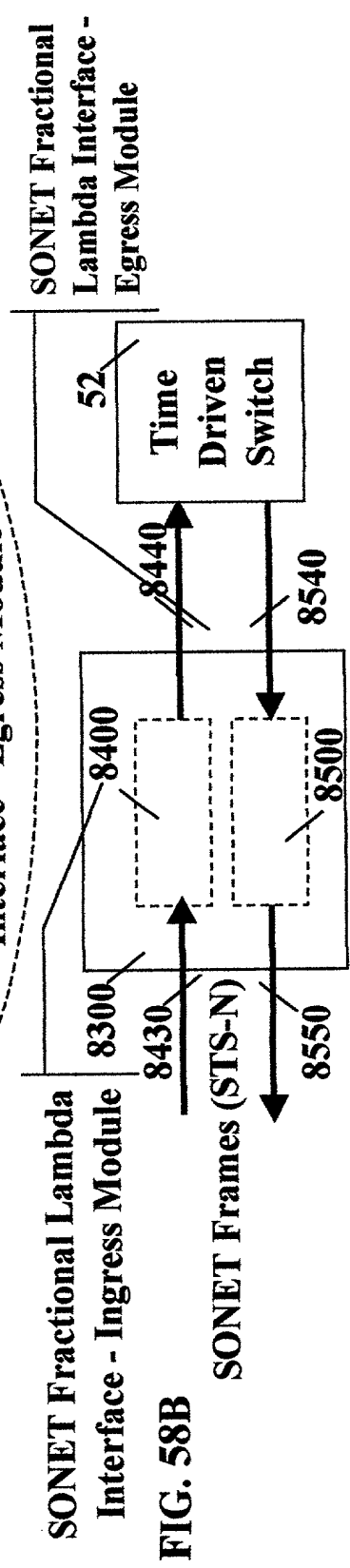
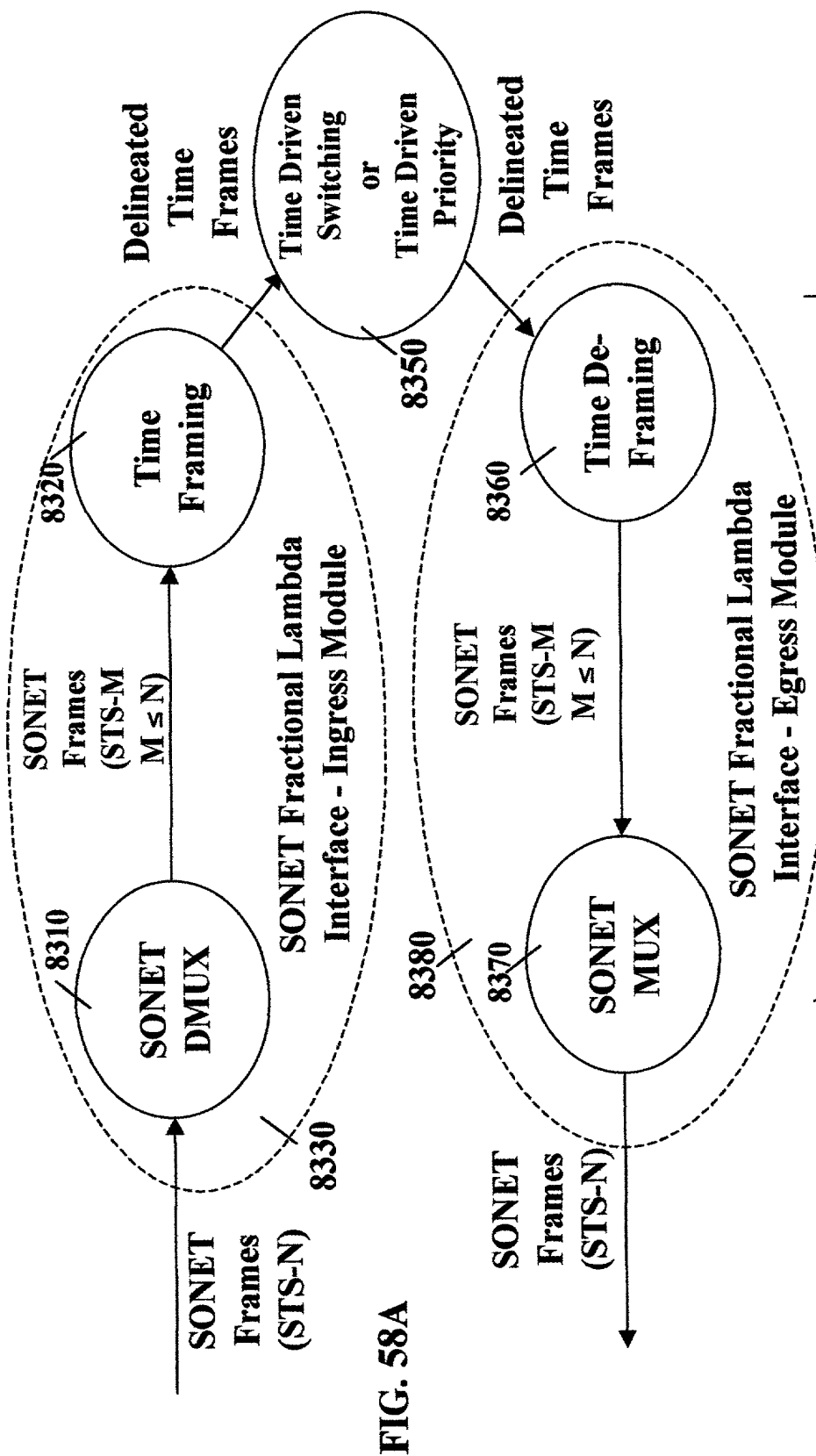


205710" T20T29660

205710" T80T 9660







205 F T O " T 8 0 T 9 6 6 0

FIG. 59

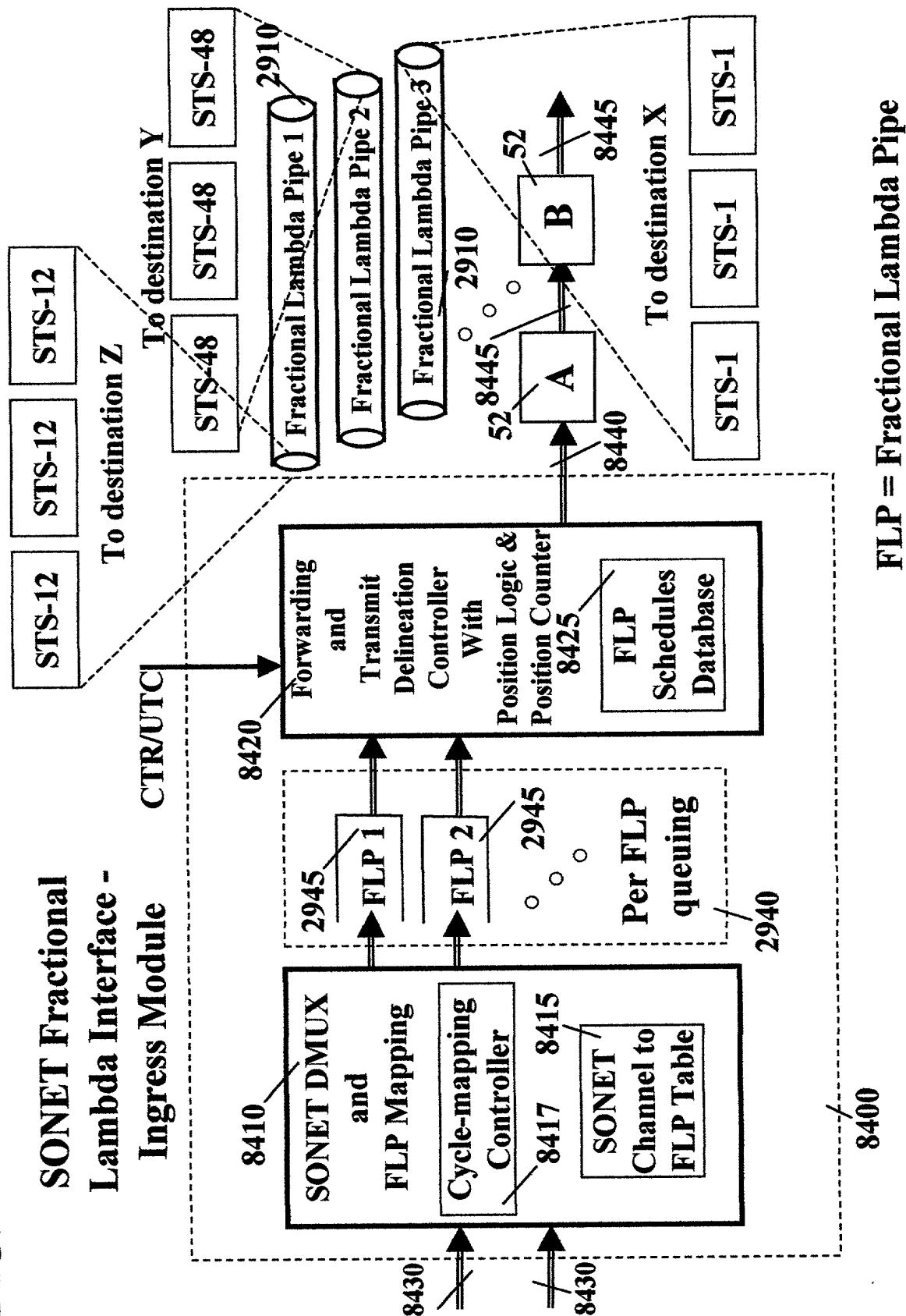
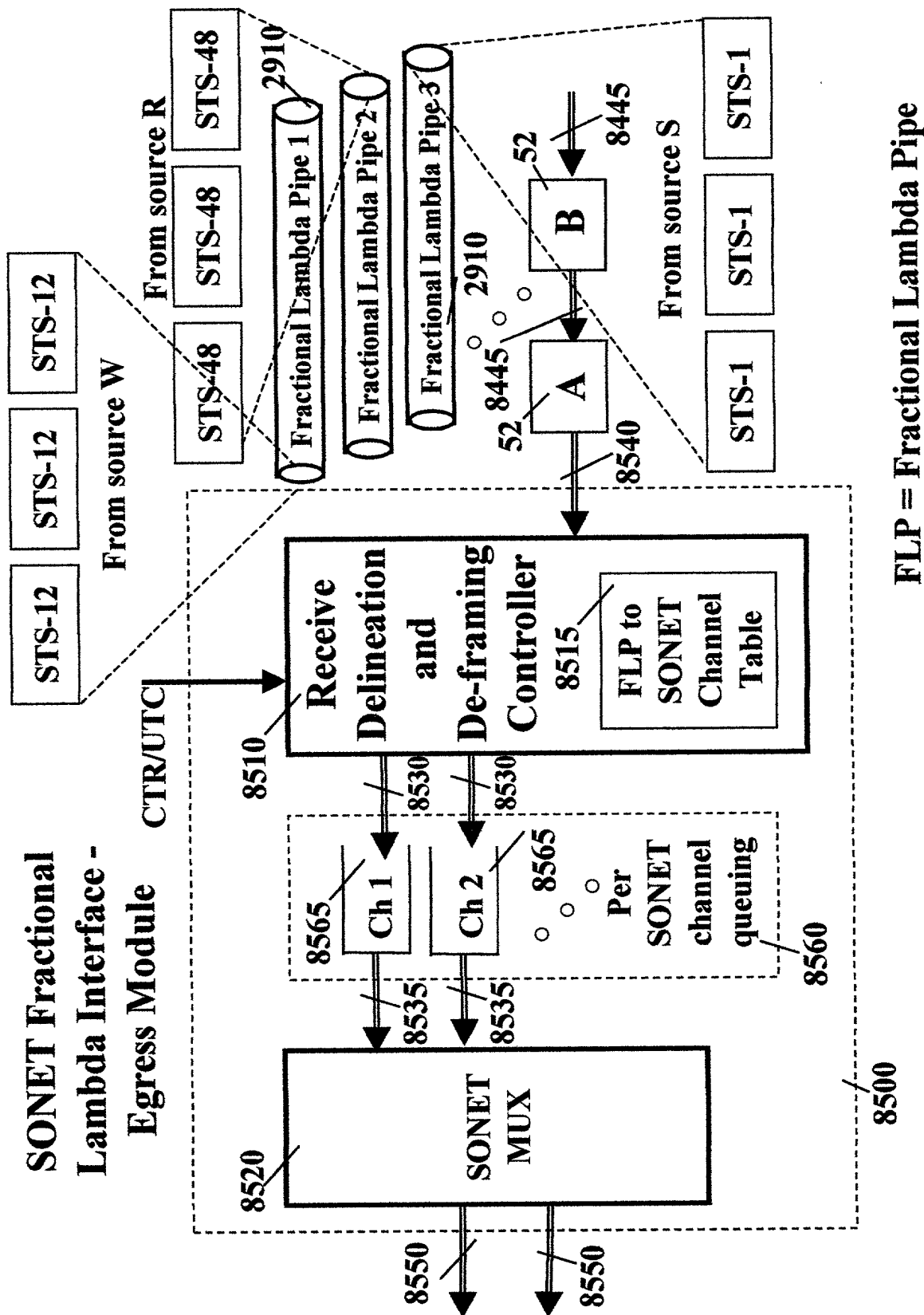
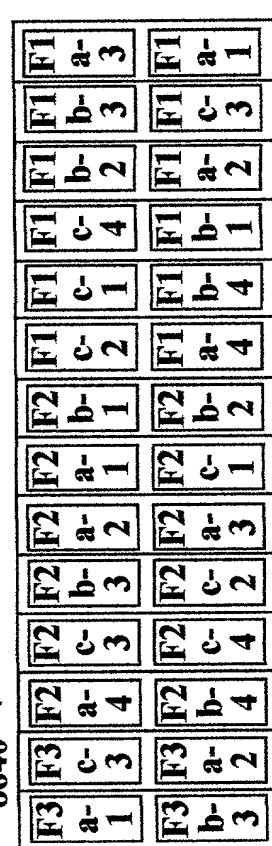
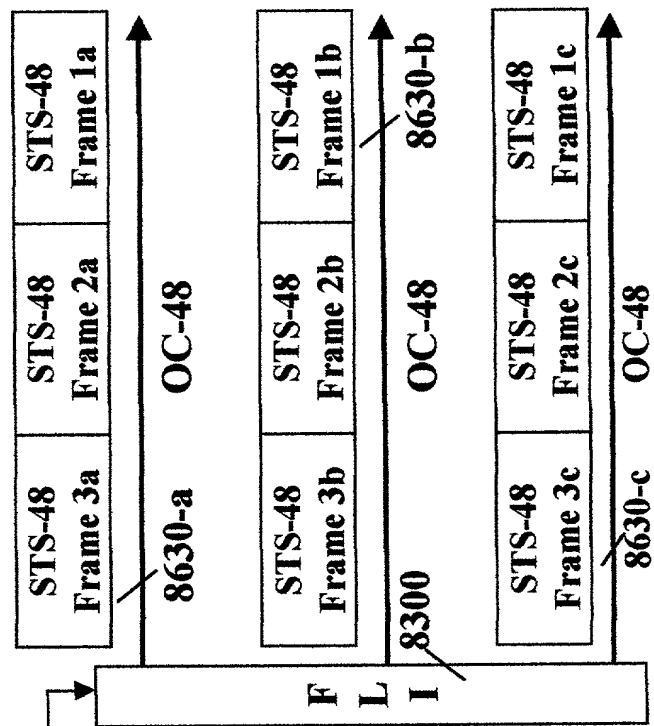
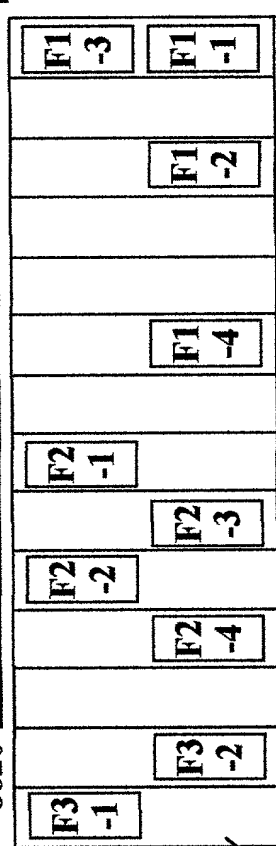
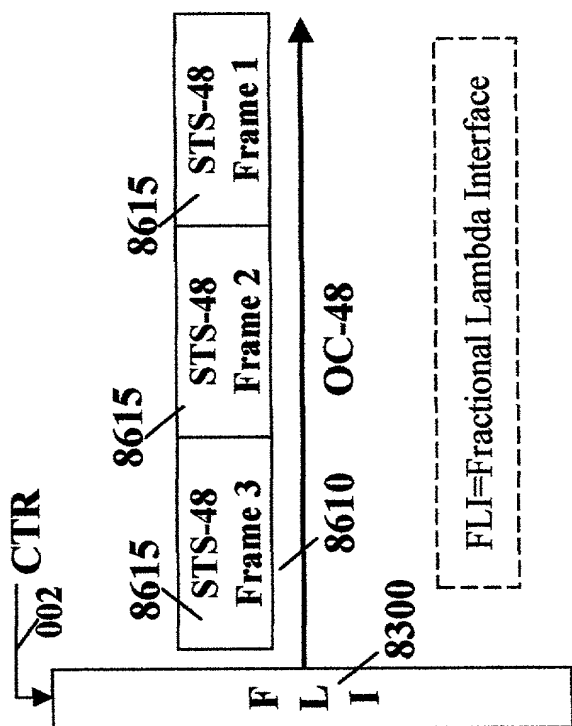


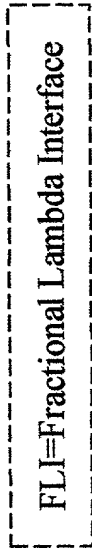
FIG. 60

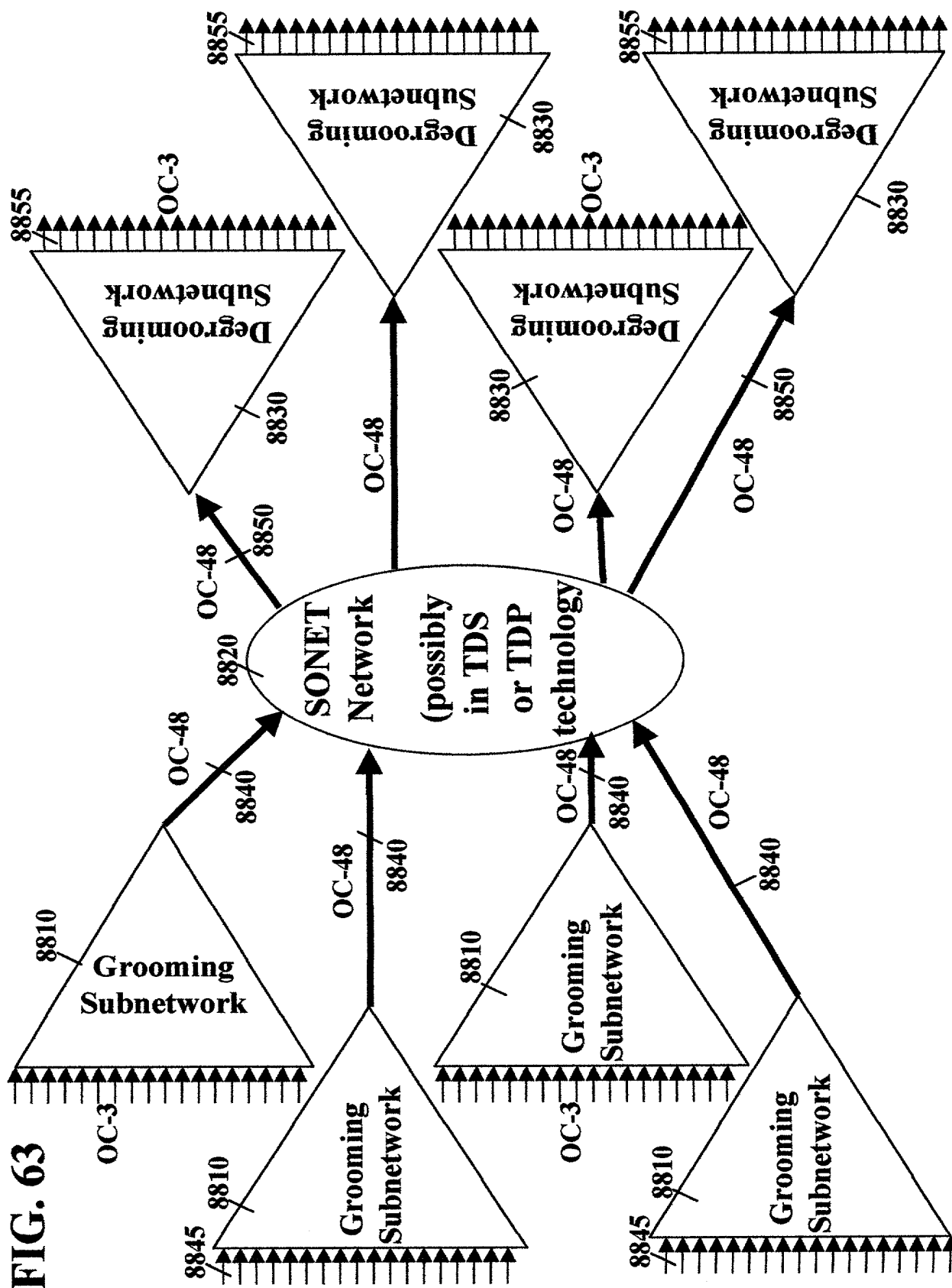
SONET Fractional
 Lambda Interface -
 Egress Module



FLP = Fractional Lambda Pipe







- SONET - synchronous optical network
- Multiplexing method: byte interleaving
- Signal hierarchy: OC-N (STS-N)
 - STS-N rate: $N \times 51.84$ Mb/s
 - Frame format: 9 rows by $90 \times N$ columns
 - capacity: $N \times 810$ bytes in 125 microsecond.
 - overhead: $N \times 27$ bytes
 - payload: $N \times 783$ bytes

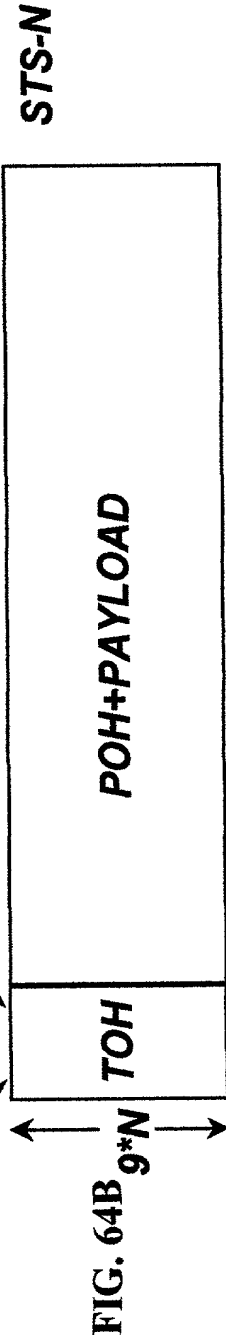
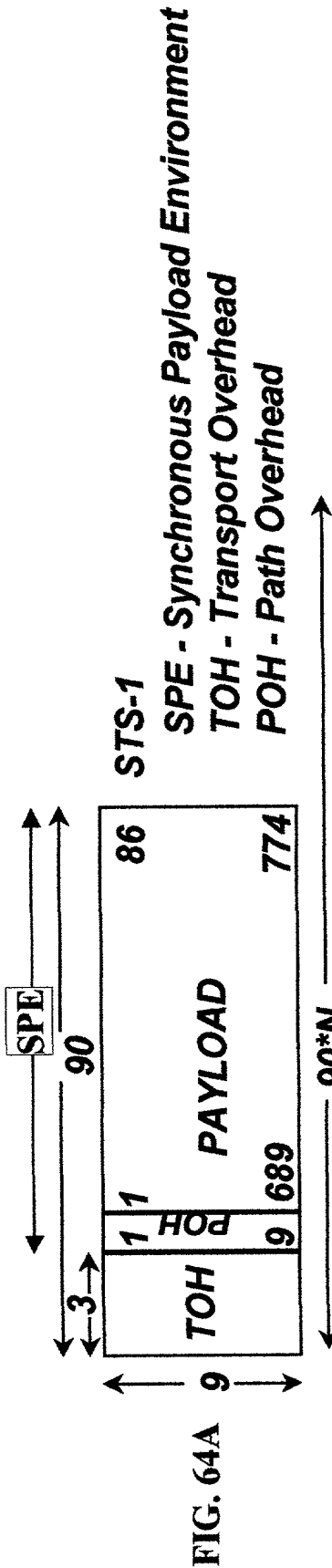


FIG. 65

